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ABSTRACT

A methodology is presented for survey and evaluation of existing buildings to determine the risk to life safety under natural hazard conditions and estimate the amount of expected damage. Damage to both structural and nonstructural building components resulting from the extreme natural environments encountered in earthquakes, hurricanes, and tornadoes is considered. The methodology has the capability of treating a large class of structural types. Three independent but related sets of procedures for estimating damage for each of the natural hazards are included in the methodology. The first set of procedures provides a means for qualitatively determining the damage level on the basis of data collected in field surveys of the building. The second set utilizes a structural analysis of the building to determine the damage level as a function of the behavior of critical elements. The third set is based on a computer analysis of the entire structure. The procedures are presented in a format which allows updating and refining. Numerical examples illustrating application of the procedures are included. (Author)

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BUILDING SCIENCE SERIES 61

EA

Natural Hazards Evaluation of Existing Buildings

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Natural Hazards Evaluation of Existing Buildings

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ABSTRACT

A methodology is presented for survey and evaluation of existing buildings to determine the risk to life safety under natural hazard conditions and estimate the amount of expected damage. Damage to both structural and nonstructural building components resulting from the extreme natural environments encountered in earthquakes, hurricanes, and tornadoes is considered. The methodology has the capability of treating a large class of structural types including braced and unbraced steel frames, concrete frames with and without shear walls, bearing wall structures, and long-span roof structures. Three independent but related sets of procedures for estimating damage for each of the natural hazards are included in the methodology. The first set of procedures provides a means for qualitatively determining the damage level on the basis of data collected in field surveys of the building. The second set utilizes a structural analysis of the building to determine the damage level as a function of the behavior of critical elements. The third set is based on a computer analysis of the entire structure. All three sets of procedures are based on the current state-of-the-art. The procedures are presented in a format which allows up-dating and refining. Numerical examples illustrating application of the procedures are included.

Key Words: Buildings; damage; disaster; dynamic analysis; earthquakes; hurricanes; natural hazards; structural engineering; tornadoes; wind.

The methodology presented in this report is the result of a research project and should be used by professionals competent in interpreting the application and results. This publication of the methodology is intended to assist professionals and not relieve anyone of professional accountability for the design and evaluation of structures. The National Bureau of Standards, the Defense Civil Preparedness Agency and the authors are not responsible for any action which may result from application of the methodology. The methodology should not be interpreted to and does not reflect the policy of either the National Bureau of Standards or the Defense Civil Preparedness Agency.

SI Conversion Units

In view of present accepted practice in this technological area, U.S. customary units of measurements have been used throughout this report. It should be noted that the U.S. is a signatory to the General Conference on Weights and Measures which gave official status to the metric SI system of units in 1960. Readers interested in making use of the coherent system of SI units will find conversion factors in ASTM Standard Metric Practice Guide, ASTM Designation E-380-72 (available from American Society for Testing and Material, 1916 Race Street, Philadelphia, Pennsylvania, 19103). Conversion factors for units used in this report are:

	Customary Unit	International (SI), Unit	Conversion Approximate
Length	inch (in)	meter (m)[a]	1 in=0.0254m
	foot (ft)	meter (m)	1 ft=0.3048m
Force	pound (lbf)	newton (N)	1 lbf=4.448N
	kilogram (kgf)	newton (N)	1 kgf=9.807N
Pressure Stress	pound per square inch (psi)	newton/meter^2	1 psi = 6895N/m^2
	Kip per square inch (ksi)	newton/meter^2	1 Ksi = 6895 $\times$ 10^{6}N/m^2
Energy	inch-pound (in-lbf)	joule (J)	1 in-lbf=0.1130 J
	foot-pound (ft-lbf)	joule (J)	1 ft-lbf=1.3558 J
Torque or Bending Moment	pound-inch (lbf-in)	newton-meter(N-m)	1 lbf-in=0.1130 N-m
	pound-foot (lbf-ft)	newton-meter (N-m)	1 lbf-ft=1.3558 N-m
Weight or Mass	pound (lb)	kilogram (kg)	1 lb=0.4536 kg
Unit Weight	pound per cubic foot (pcf)	kilogram per cubic meter (kg/m^3)	1 pcf=16.018 kg/m^3
Velocity	feet per second (ft/sec.)	Meter per second (m/s)	1 fps = 0.3048 m/s
Acceleration	feet per second squared (ft/sec^2)	meter per second squared (m/s^2)	1 ft/sec^2 = 0.3048 m/s^2

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[a] Meter may be subdivided. A centimeter (cm) is 1/100 m and a millimeter (mm) is 1/1000 m.

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1. INTRODUCTION

1.1 BACKGROUND

Much of the loss of life and property in the United States from natural hazards such as earthquakes, hurricanes, and tornadoes results from the inadequate performance of buildings in response to these extreme natural environments. Past observations have shown, however, that buildings properly designed, detailed, and constructed can withstand these environments. This involves realistic assessment of the forces produced by the environment, proper distribution of these forces to structural and nonstructural building components and providing the necessary resistance to these components in the design process, and continual inspection during construction to insure the design is correctly executed in the field.

Improved building practices incorporating new knowledge relative to natural environments and the performance of buildings will serve to mitigate future losses. Continued updating of building codes and standards, taking into account the latest research findings and experiences gained from past performance of buildings, is one aspect of improved practice. Improved practices, however, apply only to future construction. They do not affect existing buildings. The response of an existing building to an extreme natural environment will reflect the performance level inherent in the codes, standards, and construction practices in existence at the time of design and construction. During the life of the building, building practices continually improve reflecting the advancement of the state of knowledge. Thus, the real margin of safety differs from that assumed at the time of design as the state of knowledge and building practices advance. Also, deterioration during the service life of the building affects the real margin of safety. The need exists, therefore, to continually evaluate buildings with respect to the potential hazard they pose when subjected to extreme natural environmental conditions. Following such an evaluation, appropriate rehabilitation or abatement procedures may be initiated to mitigate unacceptable hazards.

Several programs aimed at evaluating the hazard posed by existing buildings in the event of an earthquake have been initiated. The city of Long Beach, California adopted an ordinance in 1971 requiring an evaluation of the earthquake safety of all buildings within the city. Procedures for conducting this evaluation, a hazard potential rating system, and alternative actions for hazard reduction were developed by Wiggins and Moran [1.1].*

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*See references listed in Chapter 6.

Following the 1971 San Fernando earthquake, the Veterans Administration undertook a program to evaluate the seismic resistance of the VA hospital facilities located in earthquake prone regions which had not been designed to resist earthquake forces [1.2]. The Naval Facilities Engineering Command has also undertaken a program to evaluate existing naval facilities [1.3]. Several studies are underway in California, including projects in San Francisco and Los Angeles dealing with existing school buildings. Although these programs are similar in nature, each uses a somewhat different method of evaluation. Furthermore, since these methods involve evaluating buildings in accordance with the requirements reflected in current building codes, they do not provide an indication of the level of risk or explicit levels of building performance in terms of life safety, protection of property, and maintenance of vital functions. They also do not provide an estimate of the amount of building damage to be expected.

Despite these current diverse activities, knowledgeable professionals recognize that "there presently are no nationally recognized effective, systematic and economical procedures for assessing the hazards of existing buildings for future loads"[1.4]. Recognizing this, the National Bureau of Standards and the Defense Civil Preparedness Agency initiated a project in June 1972 as part of the Cooperative Federal Program on Building Practices for Disaster Mitigation to develop a methodology for survey and evaluation of existing buildings to determine the risks to life safety under natural hazard conditions. While it is intended that the methodology will be incorporated into DCPA's National Shelter Program, its application can be extended to similar programs in the public and private sectors.

This report presents the methodology including the technical rationale involved in the development, instructions for applying the methodology and numerical examples illustrating its application.

1.2 OBJECTIVES OF SURVEY METHODOLOGY

The methodology developed herein deals with survey and evaluation procedures for existing buildings to determine the risk to life safety under natural hazard conditions. While the safety of building occupants cannot be evaluated directly as a consequence of a particular natural event, it can be related to building performance and resulting damage to the building. For example, partial or total collapse of a building involving structural damage and damage to nonstructural elements are potential hazards to the lives of the occupants.

In developing the methodology, consideration was given to establishing economical procedures applicable to a large number of buildings and a wide variety of structural types. It was designed for nationwide application. In meeting these requirements, evaluation procedures consistent with current professional practice reflecting the state-of-the-art were incorporated in the methodology. The procedures are presented in a format which will facilitate incorporation of new knowledge as it becomes available. The elements comprising the procedures are presented in a modular form so that each element can be updated separately.

The methodology may also be used to evaluate the effects of alternative rehabilitation techniques for hazardous structures. It thus provides a tool for upgrading existing buildings by identifying items needing strenghtening or repair.

1.3 SCOPE OF SURVEY METHODOLOGY

The natural hazard loading conditions considered in this methodology are those encountered in earthquakes, hurricanes, and tornadoes. While the source mechanism is different for each of these geophysical processes, they all impose dynamic loading. Existing historical seismic and meteorological data are used in the methodology for determining the magnitude and recurrence interval for these hazard loadings. For earthquakes, recorded seismic data were used to prepare seismicity tables for determining expected ground motion, see Appendix G. For wind loading, recently adopted standards are used. Selection of the hazard loading for a particular building evaluation must be made by the user. The loadings provided with the methodology or appropriate values supplied by the user may be employed.

The types of structures considered include braced and unbraced steel frames, concrete frames, shear wall structures, combination frame and shear wall structures, bearing wall structures, and long-span roof structures. Although no specific limitations are imposed on application of the methodology, it is intended for buildings with substantial occupancy, i.e., fifty or more people. One-and two-story residential buildings, therefore, are not considered.

For surveys involving a large number of buildings, it is advantageous to utilize several different techniques to expedite the evaluation process. For example, due to age and type of construction, certain buildings can be easily identified as potentially hazardous without resorting to a rigorous analysis. Other buildings, because of their functional nature and structural type, may warrant a detailed analysis. In view of this, three sets of evaluation procedures were included in this methodology, each set representing a different level of analytical sophistication. Hereafter, these three sets are referred to as the Field Evaluation Method, the Approximate Analytical Evaluation Method and the Detailed Analytical Evaluation Method.

In the Field Evaluation Method buildings are evaluated on a qualitative basis in terms of structural characteristics, structural configuration, and the degree of deterioration of the building. Information on these are obtained from a field survey. This method provides a rapid, inexpensive means for identifying clearly hazardous structures or potentially hazardous ones requiring a more detailed analysis to estimate damage.

In the Approximate Analytical Evaluation Method, buildings are evaluated in terms of the behavior of critical structural members. The procedure requires an analysis of the structure to identify critical members and determine the stress level induced in these members by the extreme environments. A set of building plans, specifications, and construction drawings are needed to obtain the necessary data required to perform the analysis The method can be used to determine the damage level for buildings identified by the Field Evaluation Method as requiring further analysis.

In the Detailed Analytical Evaluation Method the damage level is evaluated on the basis of the energy capacity of the structure. This procedure requires the use of a digital computer program for the evaluation. As in the Approximate Analytical Evaluation Method, the building data needed for input to the computer program would be obtained from a set of building plans, specifications and construction drawings. It is envisioned that this procedure would be used for more complex structures or critical facilities such as hospitals, communication centers, etc.

In all three methods, an acceptable level of damage is not specified since it varies with the usage and function of the building. For example, while damage to partition walls in an office building causes an obvious economic loss and possible life safety hazards, similar damage in a hospital may cause a significantly greater life safety hazard. Thus, interpretation of levels of damage predicted by the methods as they relate to life and property losses must be exercised by the user.

1.4 ORGANIZATION OF THE REPORT

The first part of the report deals with the technical basis and rationale involved in development of the methodology. The second part illustrates application of the survey and evaluation procedures included in the methodology. The first part includes chapters 2 through 4 and the second part, the Appendices.

Chapter 2 discusses, in general terms, the factors which must be included in a hazard evaluation of existing buildings. Natural hazard loadings arising from earthquakes, hurricanes, and tornadoes are discussed. The current state of knowledge on modeling techniques for various types of structures and analytical methods for evaluating structural response to dynamic loading are also included. The failure modes for structures subjected to each of the three natural hazard loadings are described.

Chapter 3 outlines the development of each of the three evaluation methods including the manner in which the various factors discussed in chapter 2 were taken into account in each method. The assumptions and limitations of each method are discussed. The effective use of the three methods for surveying a large number of structures is also considered.

Chapter 4 includes an illustrative example of a building evaluated by each method for earthquakes, hurricanes, and tornadoes. For each natural hazard considered, the structure is analyzed for these extreme environments and the results obtained from each method are compared.

Appendix A includes the Data Collection Form for the Field Evaluation and Approximate Analytical Methods and instructions for collecting the data in a field survey. A completed sample form is given for illustration.

Appendix B contains the procedures for the Field Evaluation Method. The manner in which building data are considered in the evaluation procedure and definition of the structural and nonstructural quality rating schemes used are included.

Appendix C contains the procedures for the Approximate Analytical Evaluation Method. It describes data needed for this method. Procedures for identifying critical members in a structure are presented.

Appendix D contains additional examples of completed data collection forms and analyses by each of the three methods.

Appendix E contains the computer program user's manual for the Detailed Analytical Evaluation Method.

Appendix F contains a listing of the computer program for the Detailed Analytical Evaluation Method.

Appendix G contains United States Seismicity Tables obtained using the theory presented in the Detailed Analytical Evaluation Method.

2. FACTORS AFFECTING NATURAL HAZARD EVALUATION

2.1 GENERAL

This chapter presents the reader with a brief overview of the different components which are present in a damage evaluation methodology. The physical character of the natural disaster loading mechanisms is summarized in section 2.2. This is followed by a general introduction to structural modeling (section 2.3) and structure response (section 2.4). Section 2.5 presents a pictorial description of the damage induced by the past occurrence of major natural hazards.

2.2 NATURAL HAZARD LOADINGS

A. Earthquake Loading Considerations

Through much of seismic mythology two ideas recur. The first of these is that something was imprisoned within the earth -- a whale, a giant mole, a storm, or the monstrous children of Mother Earth. The second is that earthquakes had something to do with the sea; in Greek mythology, Poseidon, brother to Zeus and god of the sea, is also the "Earthshaker," and devoutly feared.

For many years, geophysicists have attempted to describe the actual counterparts of these mythical animals and storms. At the same time, they have tried to relate these unseeable subterranean forces to their surface manifestations -- the building of mountains, the bending of ocean trenches, the tearing of seafloors, the apparent drifting of continents, volcanic eruptions, and earthquakes.

Figure 2.1 shows the planet Earth to consist of a thin crust two or three miles thick under the oceans and as much as 25 miles thick beneath the continents that covers the large, solid sphere of the rock mantle, which descends to about 1800 miles. Below the mantle is the outer core and at about 3200 miles depth the inner core. The province of earthquakes recorded thus far is from the crust to a maximum depth of about 450 miles.

Conditions thought to prevail in this high-pressure earthquake zone cannot be simulated in existing laboratories because at the base of the mantle the pressure is about 11,000 tons per square inch and the temperature is about 10,000 degrees Fahrenheit. These pressures produce a rigidity in mantle rock about four times that of ordinary steel, with an average density about that of titanium.

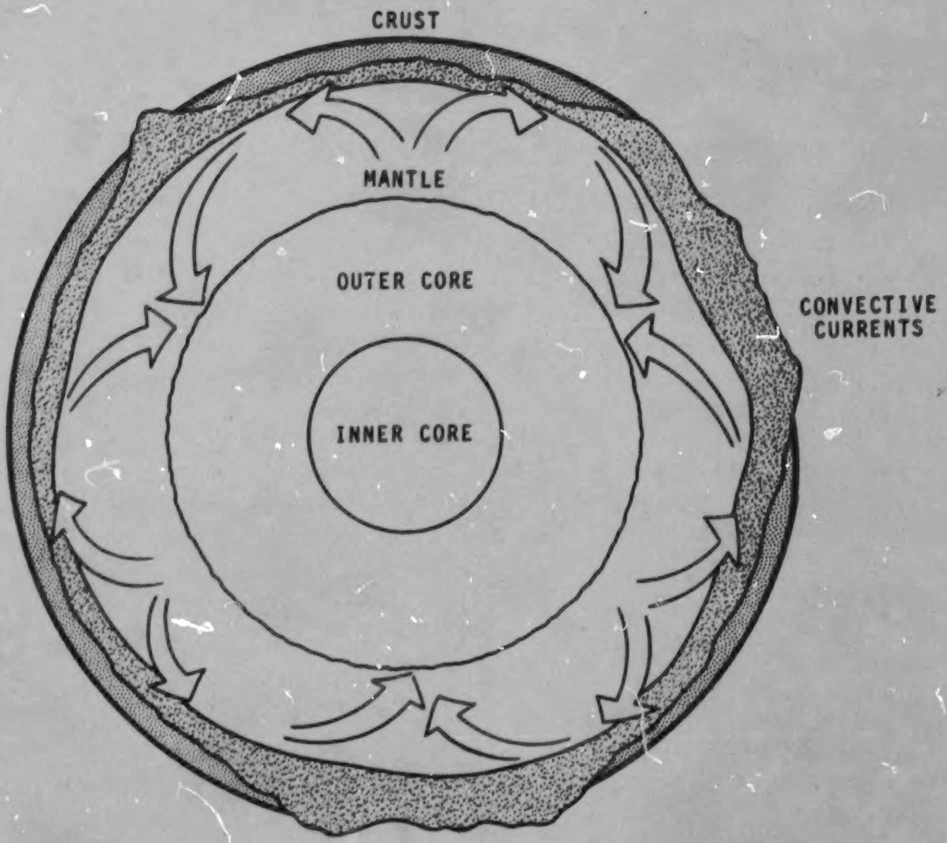

CRUST
MANTLE
OUTER CORE
INNER CORE
CONVECTIVE CURRENTS

Figure 2.1 Fluid Currents in the Earth

The very solid mantle rock behaves over periods of millions of years, like a very sluggish fluid. The temperature difference between the white-hot region near the earth's core and the cooler region near the earth's crust drives slow-moving cycles of rising and descending currents in the mantle rock itself. These currents rise beneath the ocean floor, thrust up the mid-ocean ridges, and generate the stresses which produce spine-like transverse cracks and shallow earthquakes. This is currently believed to be the mechanism which causes material to well up through the crust, replacing and spreading the old seafloor, and pushing drifting continents apart. Where these currents begin their descent at the edges of the continents they produce massive folding in the form of trenches and mountain ranges. These regions are the sites of the deeper earthquakes and of most volcanism.

Stresses generated in the earth's crust and upper mantle by convective currents are stored and under normal circumstances the rocks deform plastically, releasing pent-up energy before it builds to catastrophic levels. However, when stresses accumulate too rapidly to be removed by plastic flow, some structural compensation is necessary. Large blocks of material are slowly forced into highly strained positions along faults and held in place by a supporting structure of stronger materials. Finally, the stresses cause the supporting rocks to rupture, thus triggering a fracture. The sides of the rebounding fault move horizontally with respect to one another (strike-slip), vertically (dip-slip), or in combinations of such motion.

Sometimes all the released energy goes out in one large wrench, followed by trains of smaller tremors, or aftershocks. Sometimes the fault shift is preceded by the small structural failures, and foreshocks are therefore detected.

The slip along a fault sends out four basic types of seismic waves. Two of these wave types travel through the earth and the other two types travel only at the surface of the earth. The two types of waves which travel through the earth are called P and S waves and the two which travel along the surface are called Love and Rayleigh waves.

The primary (P) wave is longitudinal and propagates through both liquids and solids, and is usually the first signal that an earthquake has occurred. The P wave is the swiftest seismic wave, its speed varying with the material through which it passes but the speed is usually less than 4 miles per second.

As the compressional phase of the P wave passes through the earth, particles are pushed together and displaced away from the disturbance. The rarefactional phase dilates the particles and displaces them toward the earthquake source. For an object imbedded in the ground, the result is a series of sharp pushes and pulls parallel to the wave path.

The secondary (S) wave is a transverse wave and it travels at approximately one-half the speed of the primary wave. With a period and amplitude of about 2 times the associated P waves, these shear waves displace particles at right angles to the direction of wave travel. The vertical component of this movement is somewhat dampened by the opposing force of gravity; but side-to-side shaking in the horizontal can be quite destructive. Where the motion is perceptible, the arrival of the S waves marks the beginning of a new series of shocks.

The two surface waves are called Love and Rayleigh waves. The period of these waves is much greater than the body waves (e.g., 30 or more seconds versus less than two seconds). Love waves are shear type waves in the horizontal direction whereas Rayleigh waves are elliptical vertical waves. The speed of these waves is about 2-3 miles per second with the Love being slightly faster than the Rayleigh.

There are two parameters which are commonly used to describe the "size" of an earthquake. One parameter called the Modified Mercalli Intensity is an indication of an earthquake's apparent severity at a specific location. The intensity is prescribed by experienced observers using an I to XII intensity scale, see table 2.1. The primary disadvantage of this scale is that it is subjective. The Richter Magnitude of an earthquake is a measure of the energy released by an earthquake. The magnitude is based upon measurements of ground acceleration amplitudes on standardized instruments. Earthquakes of magnitude 5 or greater, usually generate ground motions which are potentially damaging to structures. Since the Richter Magnitude is on a logarithmic scale an earthquake of magnitude 6 has thirty times more energy release than a magnitude 5 earthquake and an earthquake of magnitude 7 has one-thousand times more energy than a magnitude 5 earthquake.

Magnitude also provides an indication of earthquake energy release, which intensity does not. Written in terms of equivalent tons of TNT,[2.1].

$$\log_{10} W = -4.82 + 1.5M \qquad (2.2.1)$$

where

W = tons of TNT
M = Richter magnitude

Table 2.1 MODIFIED MERCALLI INTENSITY (MMI) SCALE

I. Not felt except under especially favorable circumstances.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. Wooden walls and frames creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move.

VI. Felt by all. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken visibly, or heard to rustle.

VII. Difficult to stand. Noticed by drivers of automobiles. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, also unbraced parapets and architectural ornaments. Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of automobiles affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in floor or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated area sand and mud ejected, earthquake foundations, and craters.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Definition of Masonry A,B,C,D

Masonry A

Good workmanship, mortar and design; reinforced, especially laterally and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B

Good Workmanship and mortar; reinforced but not designed in detail to resist lateral forces.

Masonry C

Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners but neither reinforced nor designed against horizontal forces.

Masonry D

Weak materials, such as adobe; poor mortar; low standards of workmanship, weak horizontally.

Table 2.2 shows the energy-released, felt area, distance felt and maximum expected MMI for various magnitude earthquakes.

Utilizing past earthquake history one can obtain a general feeling for the seismicity of various regions of the United States. Figure 2.2 shows a map of the Continental United States with historically recorded maximum Mercalli Intensities through 1965. Utilizing historical data of this type it is possible to create a macro-seismic risk map of the United States and such a map is presented in the Uniform Building Code [2.5] and is shown in figures 2.3 and 2.4.

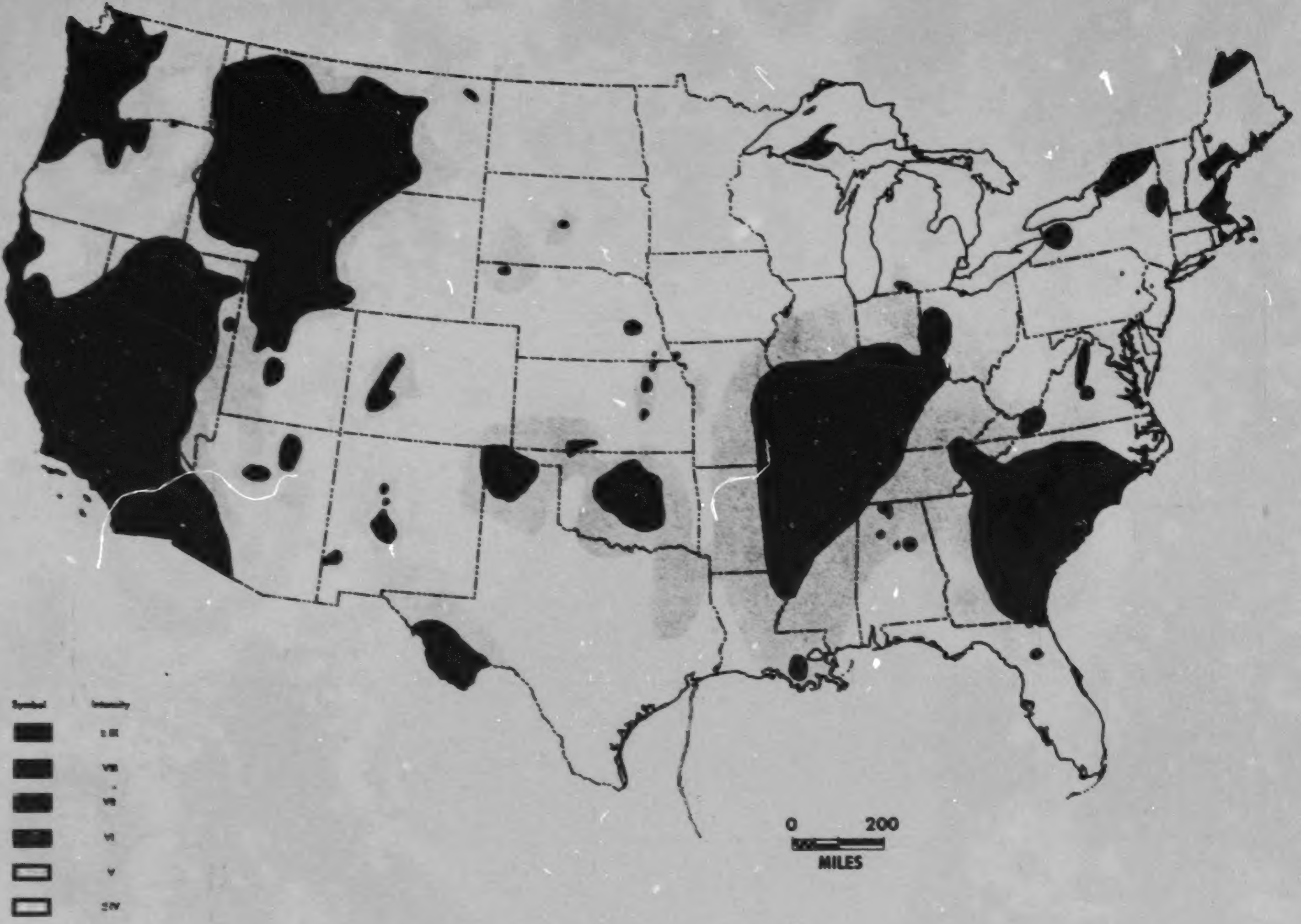
The previous description of seismicity does not directly relate to the analysis or design process because it is not expressed in terms of a parameter appropriate for such use. Because the earthquake loading is a dynamic phenomenon, potential description parameters must be related to the amplitude, duration or frequency content of earth shaking. If the loading on a structure is to be treated as an equivalent static loading then the maximum site ground acceleration is found to be an acceptable description parameter. While most building codes approach the earthquake problem on this level, the specification of building site response spectra is more rational for building structures and can be considered to be state-of-the-practice. The actual mechanics of generating earthquake loads is described in detail in chapter 3; however, for the present discussion it is sufficient to state that the characterization of such spectrum requires a knowledge of maximum earthquake induced acceleration or velocity. Therefore, it is logical to characterize the seismicity of a region by its maximum expected acceleration or velocity.

One approach to the characterization of the potential earthquake destructiveness of a particular region involves the specification of the maximum earthquake accelerations. Figure 2.5 shows a map for the State of California which indicates one expert's opinion of the maximum ground motion which can be expected [2.6]. These estimates are meant to be conservative and to represent upper bounds.

An alternate approach is the specification of maximum expected earthquake accelerations corresponding to a particular structural life. Such an approach is based on probabilistic concepts and enables the earthquake engineer to select a maximum acceleration based upon an acceptable level of risk for the conditions of service, the life of the structure which is to be designed and also upon his own view of acceptable level of risk.

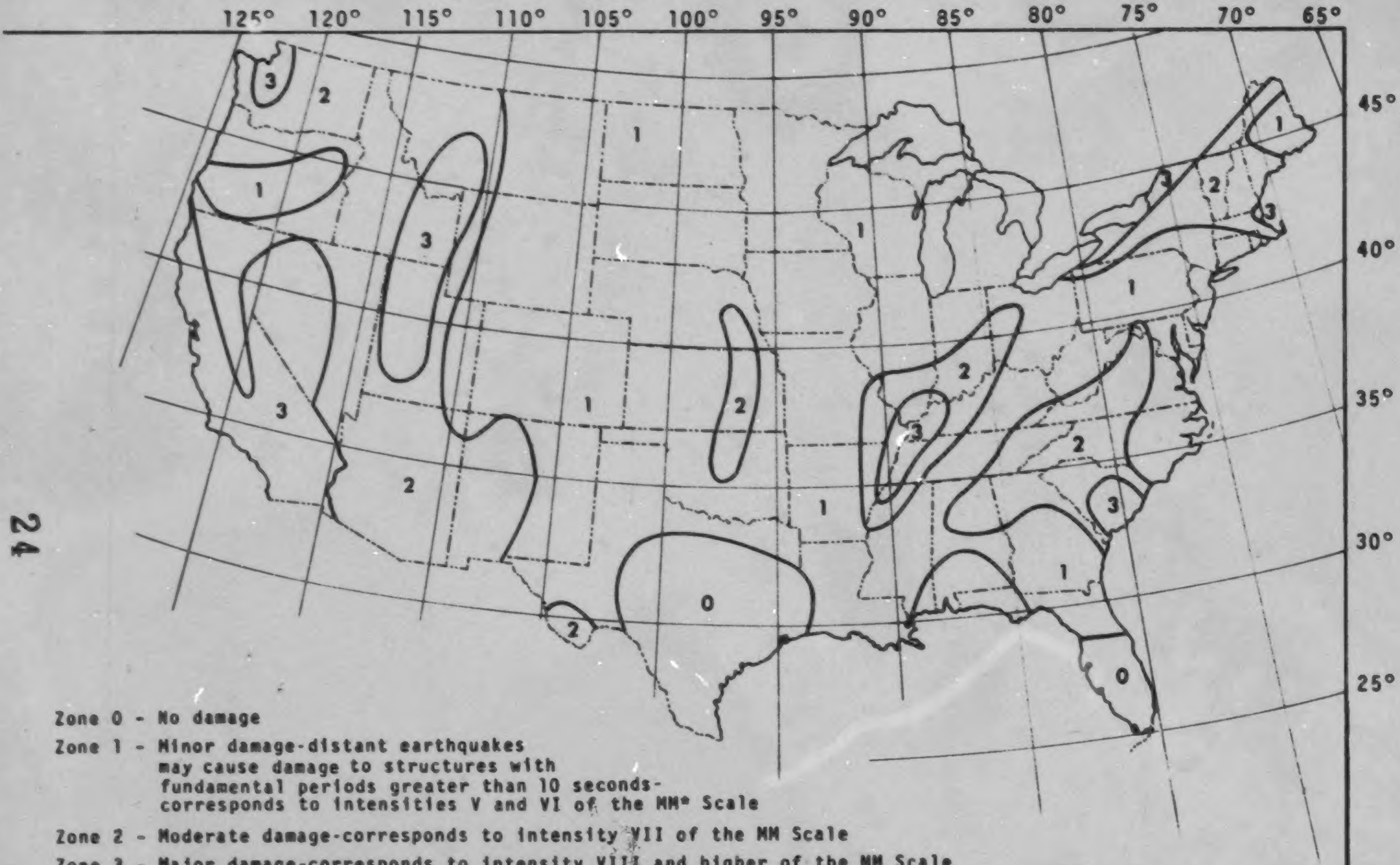
Table 2.2 EARTHQUAKE MAGNITUDE AND INTENSITY

Magnitude (Richter)	Energy-Released (Tons of TNT) [2.3]	Felt Area (square miles) [2.4]	Distance Felt (miles) [2.2]	Level of Expected Modified Mercalli [2.3]
3.0 - 3.9	0.48 - 15.2	750	15	II - III
4.0 - 4.9	15.2 - 480	3,000	30	IV - V
5.0 - 5.9	480 - 15,000	15,000	70	VI - VII
6.0 - 6.9	15,000 - 480,000	50,000	125	VII- VIII
7.0 - 7.9	480,000 - 15,000,000	200,000	250	IX - X
8.0 - 8.9	15,000,000 -480,000,000	800,000	450	XI - XII



0
200
MILES
Symbol
Intensity

Figure 2.2 Maximum Modified Mercalli Intensities Through 1965



Zone 0 - No damage

Zone 1 - Minor damage-distant earthquakes may cause damage to structures with fundamental periods greater than 10 seconds-corresponds to intensities V and VI of the MM* Scale

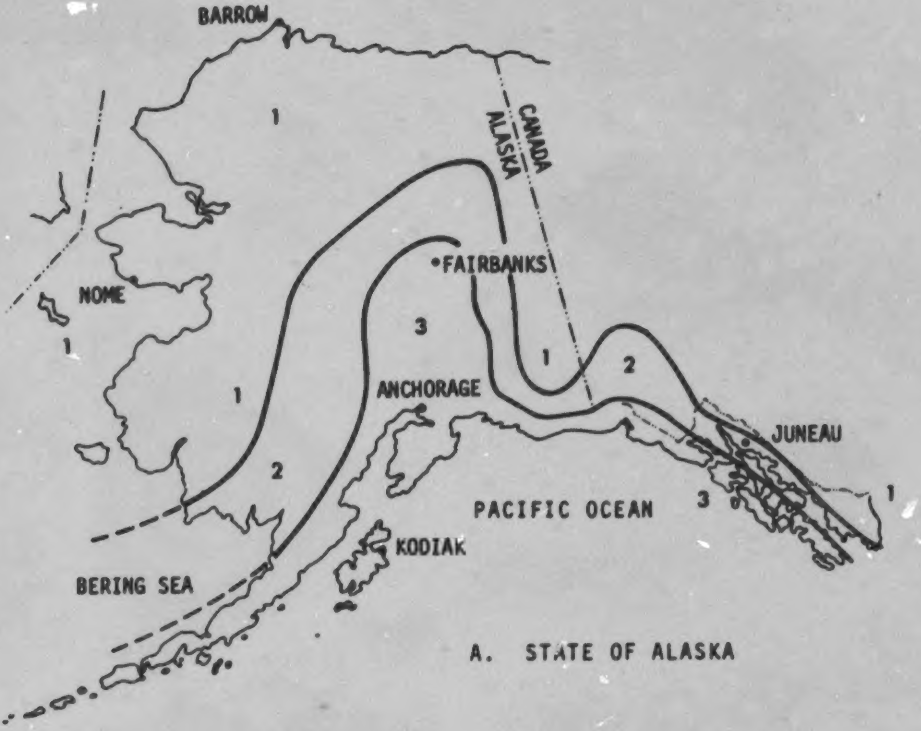
Zone 2 - Moderate damage-corresponds to intensity VII of the MM Scale

Zone 3 - Major damage-corresponds to intensity VIII and higher of the MM Scale

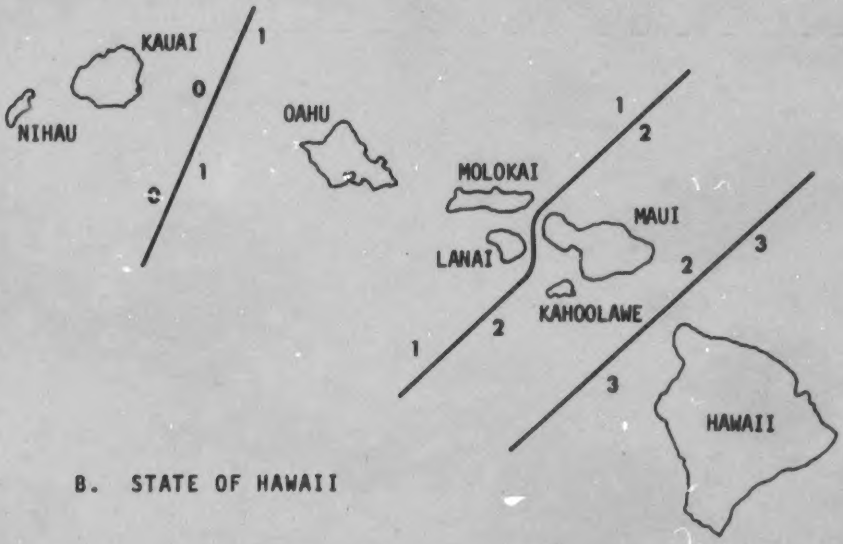
This map is based on the known distribution of damaging earthquakes and the MM intensities associated with these earthquakes evidence of strain release, and consideration of major geologic structures and provinces believed to be associated with earthquake activity. The probable frequency of occurrence of damaging earthquakes in each zone was not considered in assigning ratings to the various zones.

*Modified Mercalli Intensity Scale of 1931

Figure 2.3 Seismic Risk Map of United States


BARROW
CANADA
ALASKA
1
FAIRBANKS
NOME
1
3
1
2
1
ANCHORAGE
JUNEAU
2
1
PACIFIC OCEAN
3
KODIAK
BERING SEA

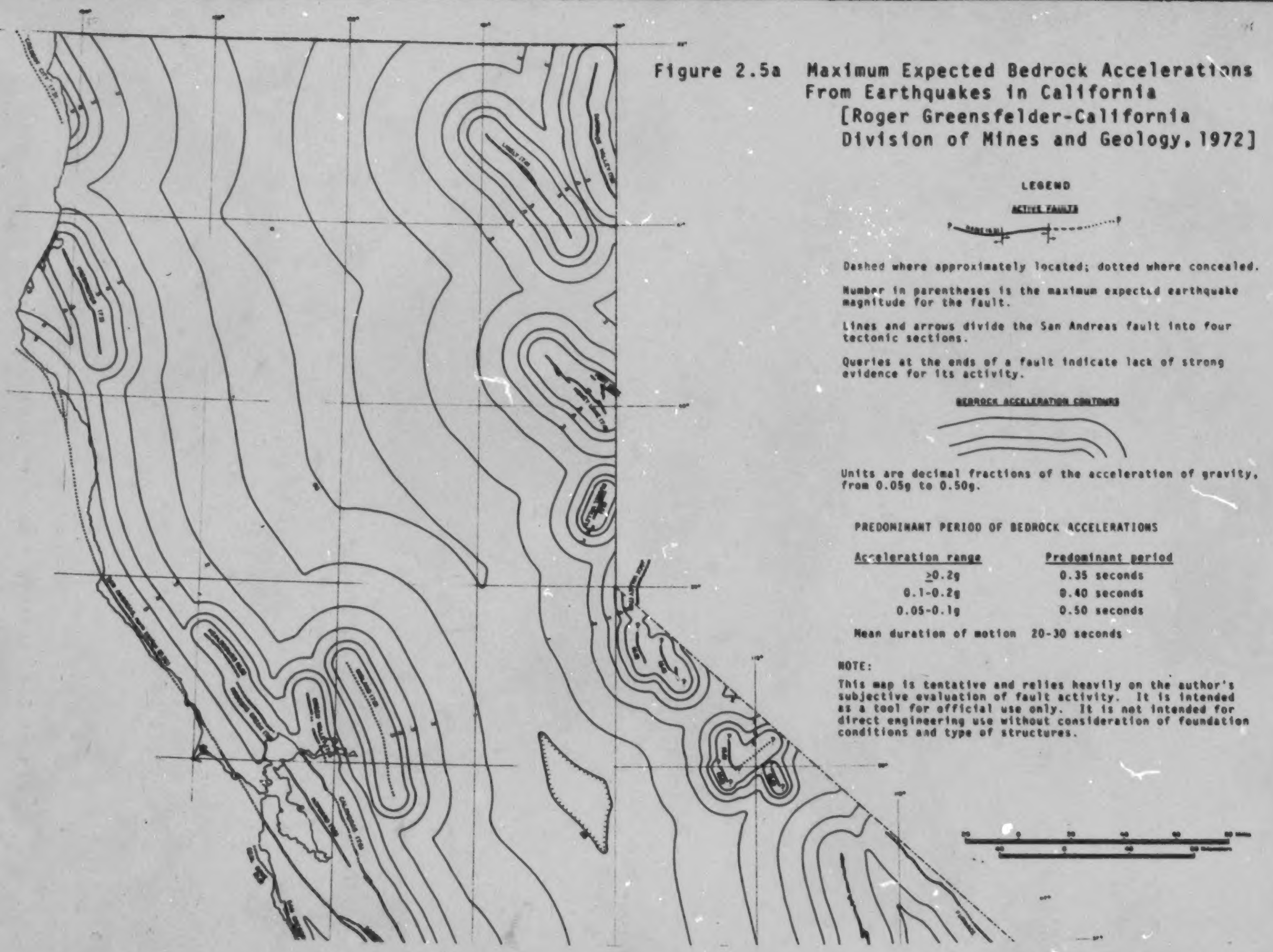
A. STATE OF ALASKA


KAUAI
1
0
NIHAU
OAHU
1
0
1
2
MOLOKAI
MAUI
LANAI
3
2
KAHOOLAWE
2
1
3
HAWAII

B. STATE OF HAWAII

Figure 2.4 Seismic Risk Map of United States

Figure 2.5a Maximum Expected Bedrock Accelerations From Earthquakes in California [Roger Greensfelder-California Division of Mines and Geology, 1972]



LEGEND

ACTIVE FAULTS

Dashed where approximately located; dotted where concealed.

Number in parentheses is the maximum expected earthquake magnitude for the fault.

Lines and arrows divide the San Andreas fault into four tectonic sections.

Queries at the ends of a fault indicate lack of strong evidence for its activity.

BEDROCK ACCELERATION CONTOURS

Units are decimal fractions of the acceleration of gravity, from 0.05g to 0.50g.

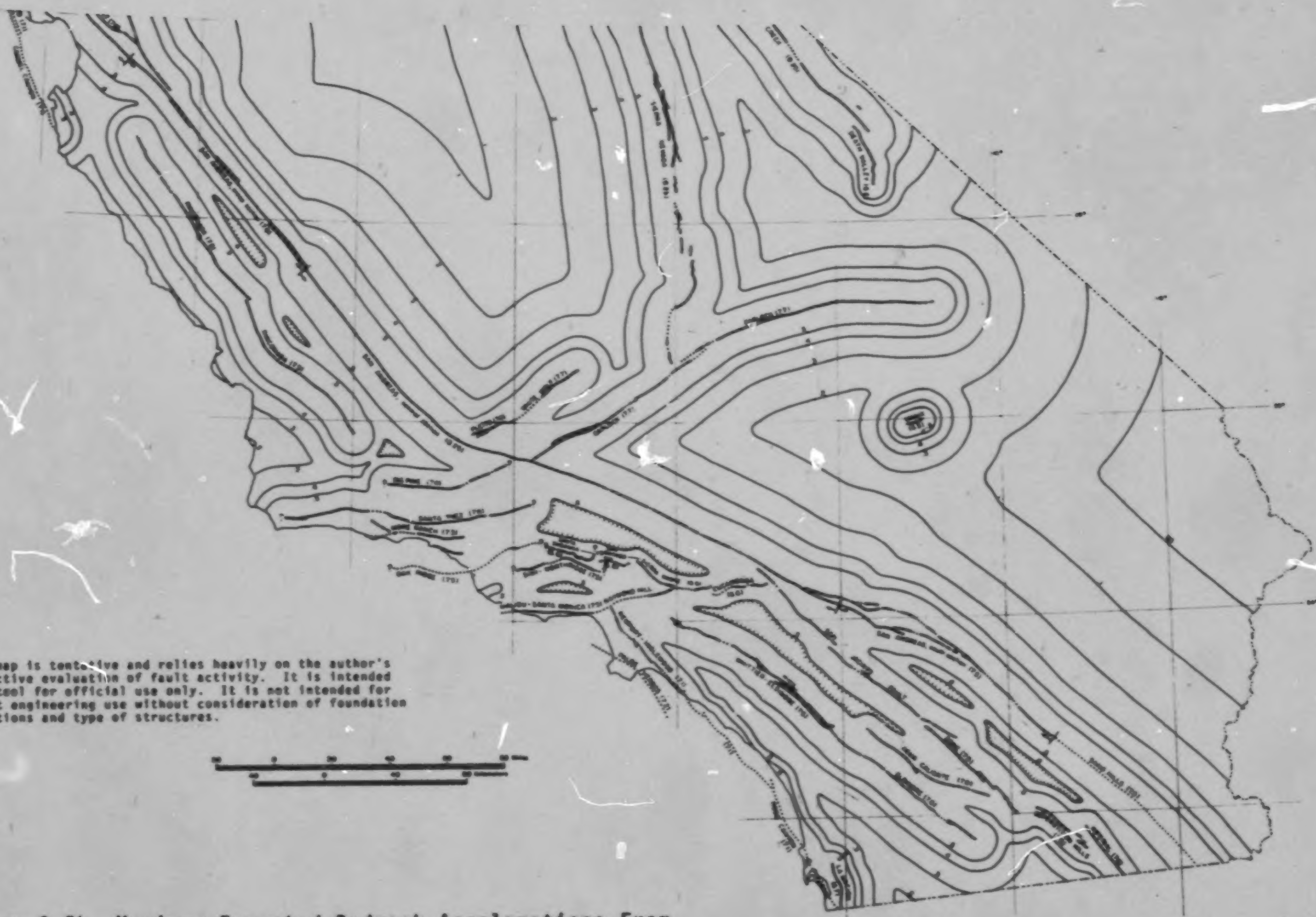
PREDOMINANT PERIOD OF BEDROCK ACCELERATIONS

Acceleration range	Predominant period
≥0.2g	0.35 seconds
0.1-0.2g	0.40 seconds
0.05-0.1g	0.50 seconds

Mean duration of motion 20-30 seconds

NOTE:

This map is tentative and relies heavily on the author's subjective evaluation of fault activity. It is intended as a tool for official use only. It is not intended for direct engineering use without consideration of foundation conditions and type of structures.



NOTE:

This map is tentative and relies heavily on the author's subjective evaluation of fault activity. It is intended as a tool for official use only. It is not intended for direct engineering use without consideration of foundation conditions and type of structures.

Figure 2.5b Maximum Expected Bedrock Accelerations From Earthquakes in California [Roger Greensfelder-California Division of Mines and Geology, 1972]

Figure 2.6 shows one such map for the southern California area [2.7]. The methodology presented in section 3.4 of this report can alternatively be used to create seismic zoning maps. At the present time, such maps do not exist; however, the maximum hardrock velocities for several United States cities are shown in table 2.3. These maximum velocities are based upon earthquakes of a 100 year return period.

The preceding methods of characterizing seismic activity are often called macro-seismicity characterizations because they characterize large geographic region. Micro-seismic characterization is an improvement upon macro-seismic characterization in the sense that it attempts to characterize the seismicity of a smaller, or more local, region. Because of governmental considerations, micro-seismic characterization (often called micro-zoning or seismic element zoning) is most commonly done for city or county governments. In such a study, the local soil conditions and the location of local earthquake faults can be studied in more detail and more accurately incorporated into the seismicity characterization. The descriptive parameter for the micro-seismicity study can still be either deterministic (i.e., specifying the maximum possible ground acceleration) or probabilistic (i.e., specifying the maximum acceleration based upon structural life and acceptable level of risk). As an example of such a micro-seismic characterization, figure 2.7 shows a micro-seismic zoning map for the City of Long Beach, California [1.1].

The loads on a structure generated by an earthquake can result from ten basic mechanisms:

1. Shaking the structure
2. Shaking the ground beneath the structure, causing settlement
3. Shaking the ground beneath the structure, causing foundation failure
4. Ground lurching
5. Ground liquefaction
6. Earth surface faulting
7. Slope failure into or beneath structure
8. Tsunami water wave
9. Seiche water wave
10. Dam failure and resulting water surge loads.

This study deals with only loading mechanism No. 1 since the greatest percentage of expected earthquake damage results from this failure mechanism.

B. Wind Loading Considerations

The wind load exerted on a structure from non-tornado and hurricane conditions is a very significant design factor. A building must be designed for loads resulting from severe winds and often, from a design point of view, it is these wind loads and not the earthquake loads which govern the design.

Figure 2.3 showed a seismic risk map for the United States as presented in the Uniform Building Code [2.5]. This map characterized in a general way the historical seismic activity of the United States. Figure 2.8 shows a relative characterization of wind loading over the United States as presented in the Uniform Building Code. Section 3.4 of this report presents a more detailed discussion of the loading problem. However, at this point it is important to recognize, that wind loads are regionally dependent. In fact, the same macro- and micro-regional concepts which have been alluded to for seismic characterization apply to wind characterization where the local geographical conditions strongly influence the local wind environment at a site.

C. Tornado Loading Considerations

A tornado is a violently revolving column of air. A funnel is caused by violent convection from intense sun heating of the ground, aided by opposing winds of greatly differing temperatures. The tornado develops below a heavy cumulo-nimbus cloud mass. The funnel may reach the ground where it is then dragged by friction. The tornado dies out in the reverse direction. Rotation of the funnel may be either clockwise or counterclockwise. The diameter of the funnel is usually around 1,000 feet, although there may be considerable variation. Because of the rotating character of the funnel there exist high wind speeds at the eye of the tornado (ranging up to about 300 miles per hour) and, because of centrifugal effects, the barometric pressure at the eye is very low. An updraft of wind at the center of the tornado may have wind speeds up to 200 miles per hour.

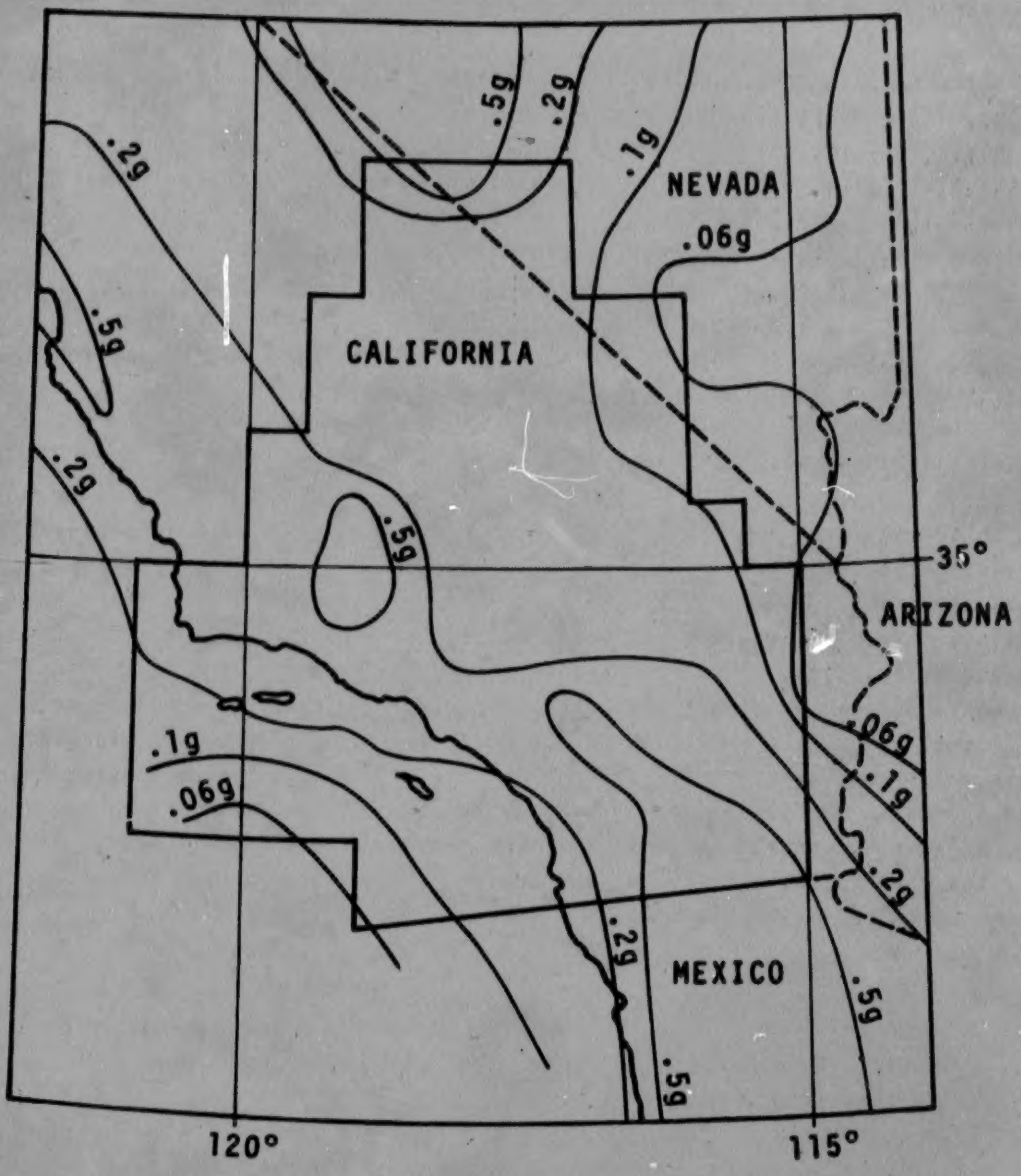

.5g
.2g
.1g
NEVADA
.2g
.06g
.5g
CALIFORNIA
.2g
.5g
35°
ARIZONA
.06g
.1g
.1g
.06g
.2g
.2g
MEXICO
.5g
.5g
120°
115°

Figure 2.6 Accelerations With a 100-Year Return Period (From Milne and Davenport[2.7])

Table 2.3 MAXIMUM HARDROCK VELOCITIES FOR EARTHQUAKES OF 100 YEAR RETURN PERIOD

STATE: CITY	MAXIMUM HARDROCK VELOCITY (inches/second)
Alaska : Anchorage	2.608
Arizona : Phoenix	0.213
Arkansas : Little Rock	0.855
California : Los Angeles	4.656
: Sacramento	1.001
: San Diego	1.112
: San Francisco	7.101
Georgia : Atlanta	0.354
Hawaii : Honolulu	0.203
: Hilo	1.760
Idaho : Idaho Falls	0.511
Illinois : Chicago	0.575
Indiana : Indianapolis	0.556
Kansas : Wichita	0.239
Kentucky : Louisville	1.080
Massachusetts : Boston	0.562
Missouri : St. Louis	1.778
Montana : Helena	5.849
Nebraska : Omaha	0.226
Nevada : Las Vegas	2.356
: Reno	1.930
New Mexico : Albuquerque	1.174
New York : New York	0.910
Ohio : Cincinnati	0.565
Oklahoma: Oklahoma City	0.486
Oregon : Eugene	1.551
: Portland	1.702
Pennsylvania : Pittsburgh	0.298
South Carolina : Columbia	0.391
Tennessee : Memphis	1.979
Utah : Salt Lake City	2.616
Washington : Seattle	1.801
Washington, D.C.	0.347

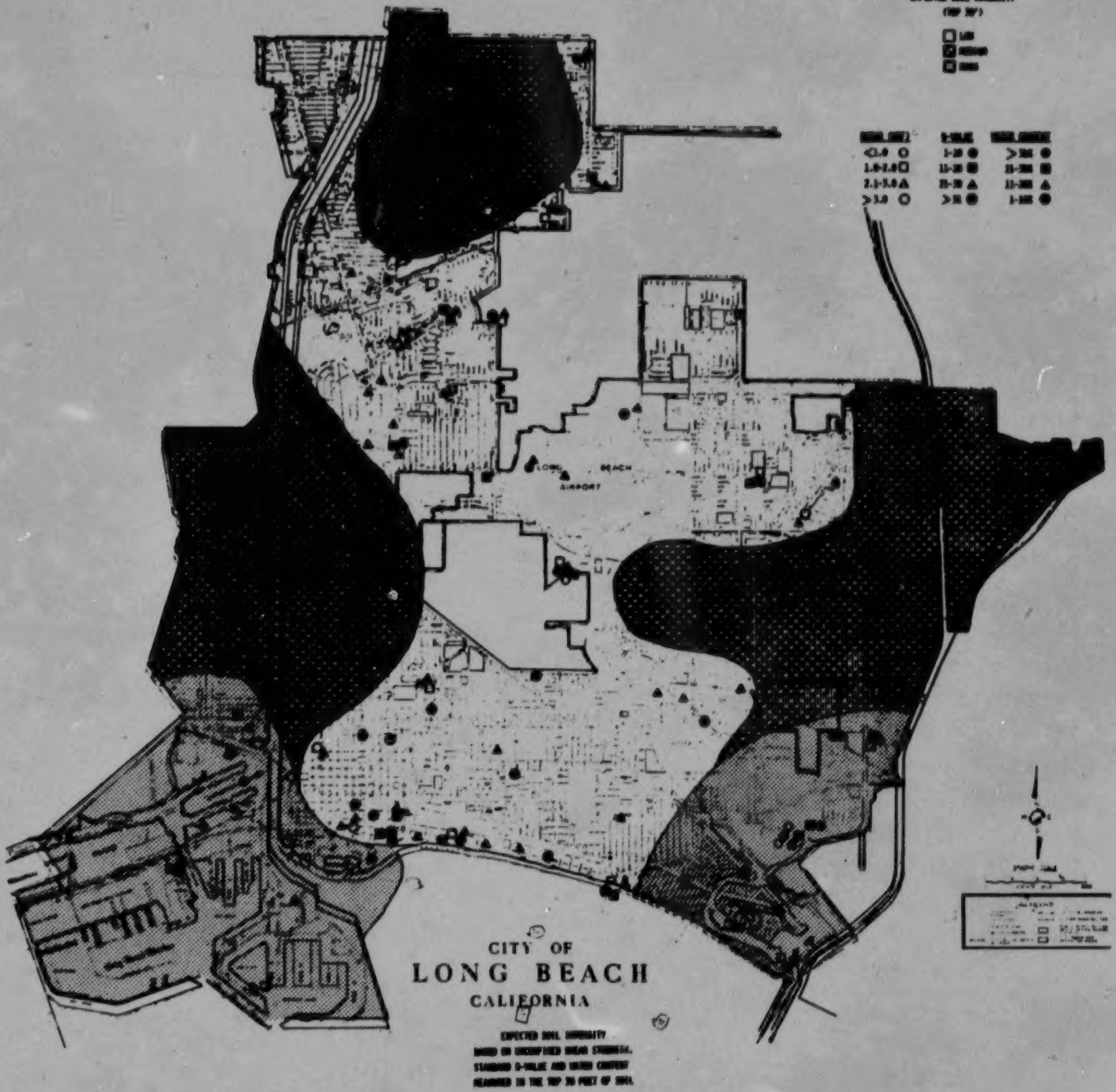

LONG BEACH
AIRPORT
CITY OF
LONG BEACH
CALIFORNIA

Figure 2.7 Micro-zoning Map for the City of Long Beach, California

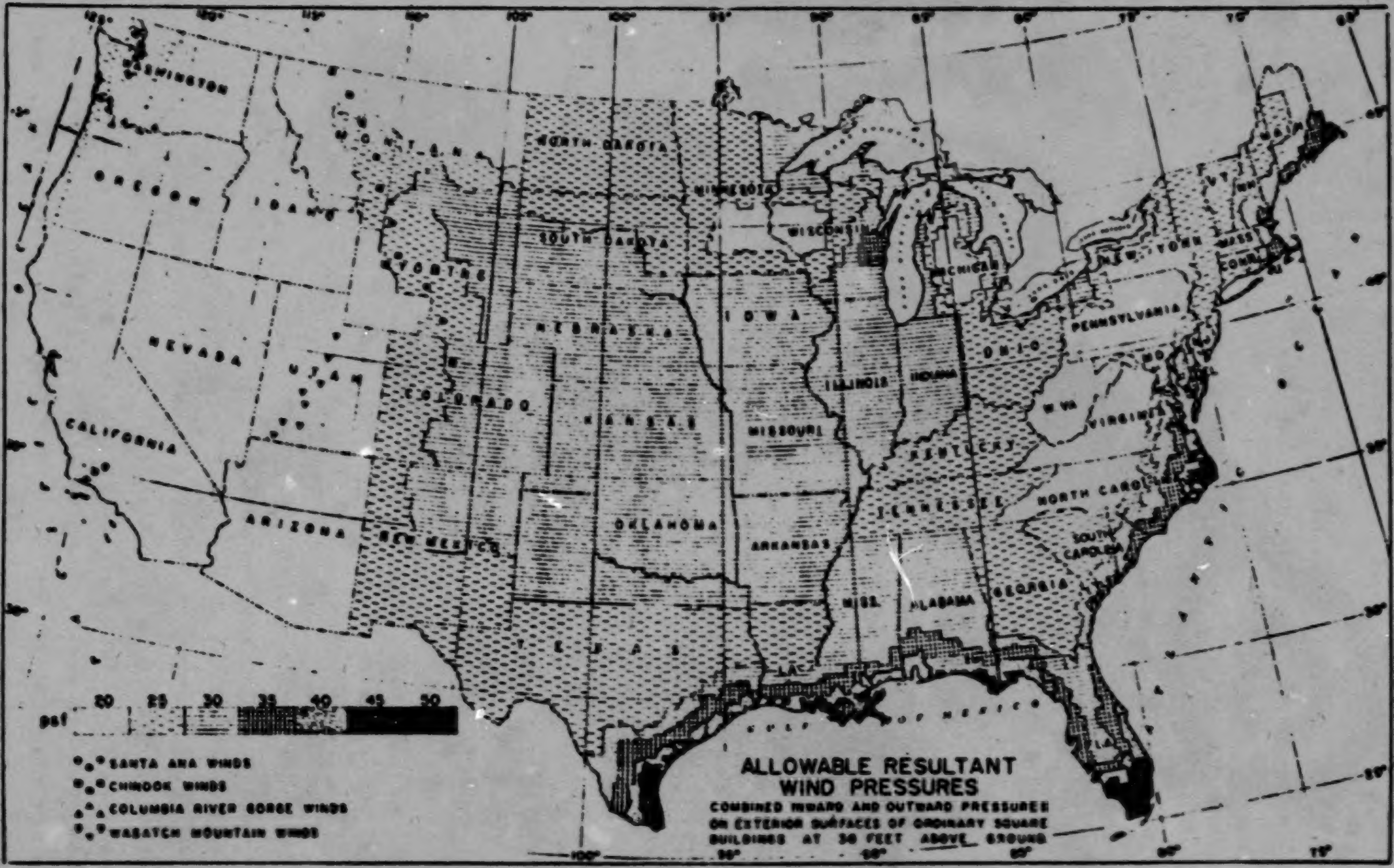

ALLOWABLE RESULTANT WIND PRESSURES
COMBINED INWARD AND OUTWARD PRESSURES ON EXTERIOR SURFACES OF ORDINARY SQUARE BUILDINGS AT 30 FEET ABOVE GROUND
psf 20 25 30 35 40 45 50
SANTA ANA WINDS
CHINOOK WINDS
COLUMBIA RIVER GORGE WINDS
WASATCH MOUNTAIN WINDS
WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
SOUTH DAKOTA
WYOMING
NEVADA
UTAH
COLORADO
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
MASS
CONN
VT
NH
MAINE
MD
W VA
VIRGINIA
CALIFORNIA
KANSAS
MISSOURI
KENTUCKY
NORTH CAROLINA
SOUTH CAROLINA
TENNESSEE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
MISS
ALABAMA
GEORGIA
TEXAS
LA
FLA
GULF OF MEXICO
125°
120°
115°
110°
105°
100°
95°
90°
85°
80°
75°
70°
65°
45°
40°
35°
30°
25°

Figure 2.8 Regional Variation of Wind Loads

Most United States tornadoes occur east of the Rocky Mountains in the eastern region of the Great Plains--from Iowa to Texas. Figure 2.9 shows a map of the United States summarizing the mean annual frequency of tornado occurrences. Paths of tornadoes are usually short, ranging from several miles to a few hundred miles and they travel from southwest to northeast at speeds ranging from 10-50 miles per hour. Tornadoes are most often formed in association with thunderstorms, and therefore, accompanying hail or rain is common.

Since a tornado is a violent disturbance involving high wind speeds, the common approach for the design of buildings is the specification of a design wind velocity. This velocity is used to calculate loading on the structure using experimental and/or analytical wind velocity-wind pressure relationship. The dynamic character of the wind pressures on the structure, as well as the structure itself, are usually incorporated into the design process by using a gust factor. This factor multiplies the predicted static wind pressures which, when used in response calculations, will be approximate but acceptable for engineering purposes.

D. Hurricane Loading Considerations

A hurricane is a tropical storm, originally applied to storms in the West Indies only, but a term now applied to this type of storm in other parts of the world. The name is derived from the word "hurracan" of the Arawak-speaking Indians of the West Indies.

In the eastern United States the hurricane season lasts roughly from June to October. In midseason, August and September, hurricanes develop mainly near or to the east of the Lesser Antilles. Early and late in the season, in June and from the latter part of September onward, the area with most frequent formation is the western Caribbean. The Gulf of Mexico also is a breeding ground for hurricanes, as is the Pacific just off the Central American coast, see figure 2.10.

After formation, most hurricanes move northwest, gradually turning more directly north as they move out of the tropics. The United States intercepts all hurricanes moving northward in the Gulf, and since the land mass extends further east with increasing latitude, it also intercepts many hurricanes moving northward on the ocean side of Florida. Some of the most extensive damage suffered from hurricanes has been sustained in New England. This damage has resulted partly from the wind, especially the effects of wind upon the sea near coasts, but also from floods following heavy rains in the mountainous sections of New England.

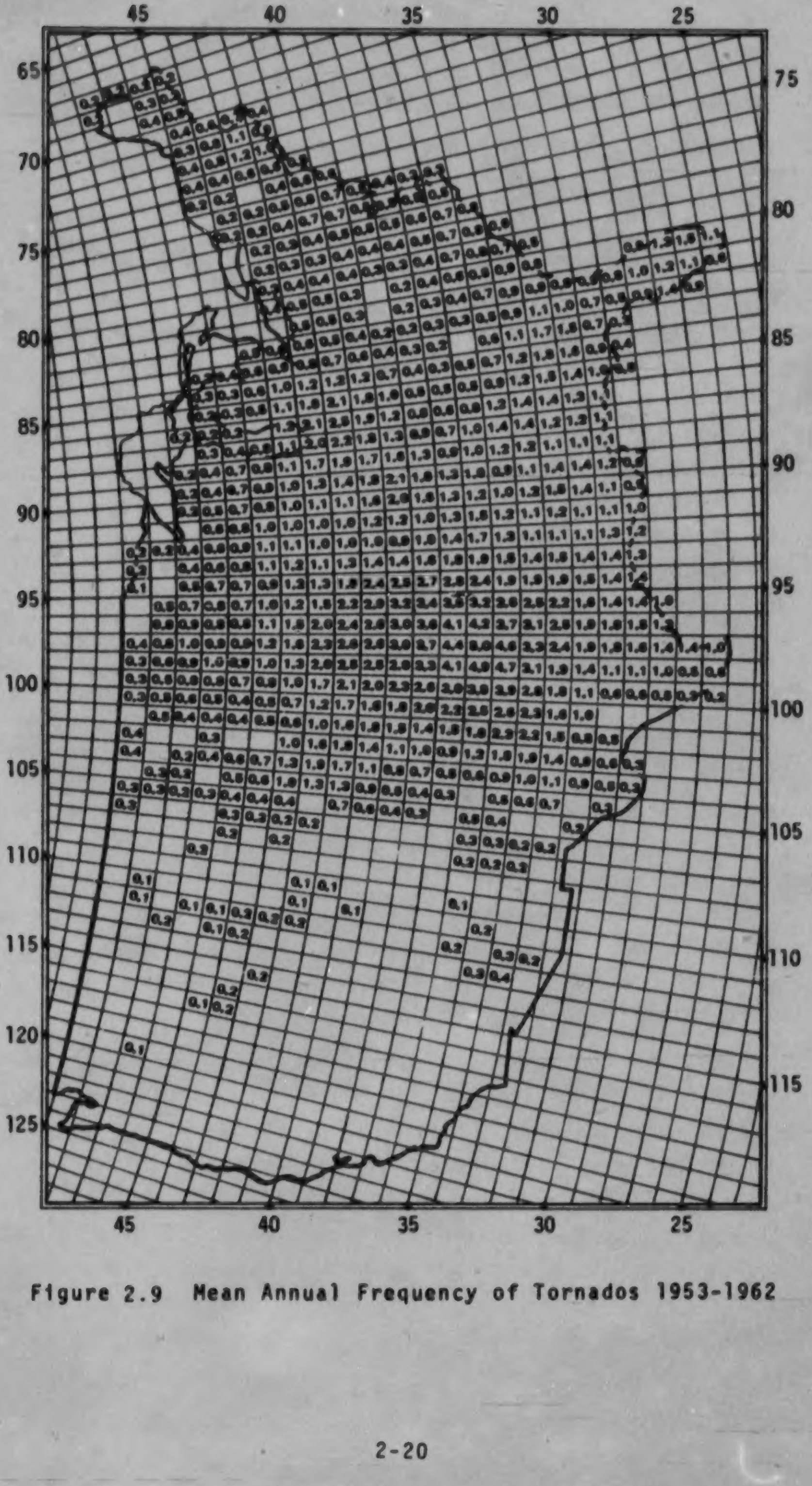

45
40
35
30
25
65
70
75
80
85
90
95
100
105
110
115
120
125
75
80
85
90
95
100
105
110
115

Figure 2.9 Mean Annual Frequency of Tornados 1953-1962

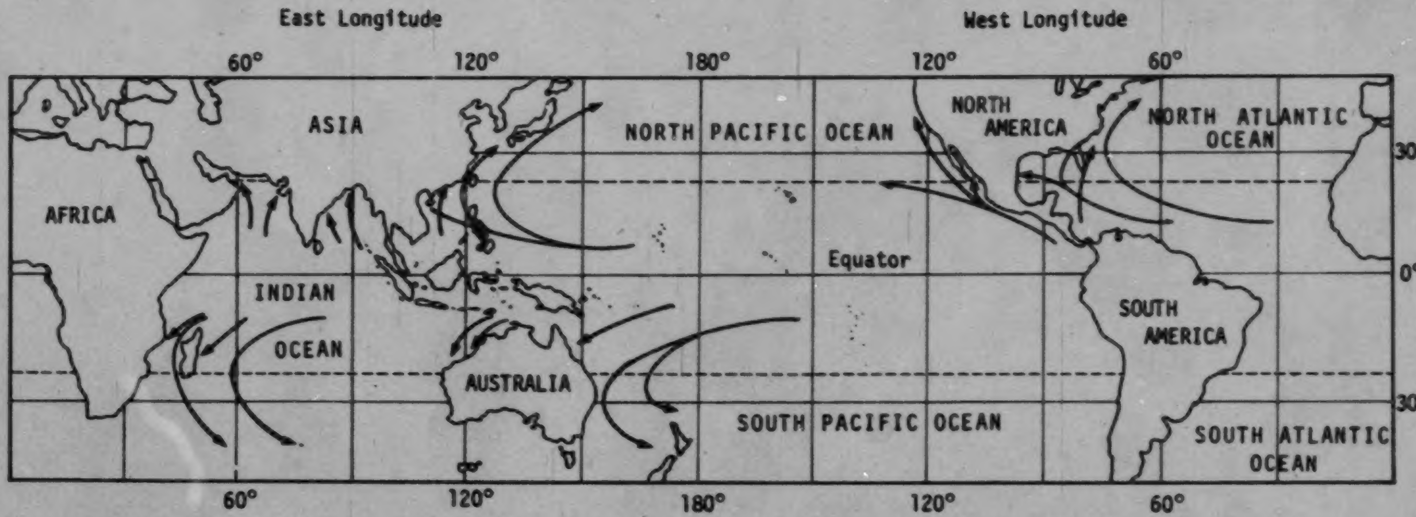

East Longitude
West Longitude
60°
120°
180°
120°
60°
30°
0°
30°
ASIA
AFRICA
INDIAN
OCEAN
AUSTRALIA
NORTH PACIFIC OCEAN
Equator
SOUTH PACIFIC OCEAN
NORTH
AMERICA
NORTH ATLANTIC
OCEAN
SOUTH
AMERICA
SOUTH ATLANTIC
OCEAN
60°
120°
180°
120°
60°

Figure 2.10 Paths Taken by Hurricanes

Hurricanes result from convective heating. The moist, warmed air at the water's surface, being lighter than its environment, is forced up and replaced by the cooler, denser, surrounding air which blows spirally inward around the center or "eye" (see figure 2.11). The rotation is counter-clockwise.

The speed of travel of the hurricane ranges from 10 to 30 miles per hour and its diameter, when matured, varies from 25 to 500 miles. Like a tornado, the barometric pressure in the "eye" is low. Heavy precipitation and high wind speeds (i.e., greater than 75 miles per hour) accompany hurricanes.

The loads on buildings resulting from hurricanes are, like tornadoes, assumed to be related to wind velocities. Mean wind velocities and resulting wind induced building pressures are amplified to take into account the dynamic characteristics of the winds and the building. A gust factor is used for this amplification.

2.3 STRUCTURAL CHARACTERIZATION

The continuous evolution of analytical and experimental structural engineering enables the engineer to continuously improve upon his analytical representation of reality. Increased application of the computer in recent years has enabled the engineer to use a more detailed analytical model of a building. However, in the final analysis the choice of an analytical model continues to primarily depend upon the following three factors: (1) the type of loading -- static or dynamic, (2) the desired response parameters, and (3) the geometric and structural layout of the building.

If the loading acting on a building is static then only the building's stiffness characteristics need be modeled. The analytical building model may be detailed or gross. Models of the former type usually involve matrix methods wherein the stiffness characteristics of each building member are represented using a member stiffness matrix. These elemental stiffness matrices are then combined to form the complete building stiffness matrix. The model resulting from this approach is often referred to as a finite element model. At the other extreme, building models of the latter type represent all structural members at a particular floor with one interstory stiffness element. The detailed building model is usually used when the engineer is concerned with estimating the stresses in the structural members whereas the gross model is used to obtain general estimates of building floor displacements.

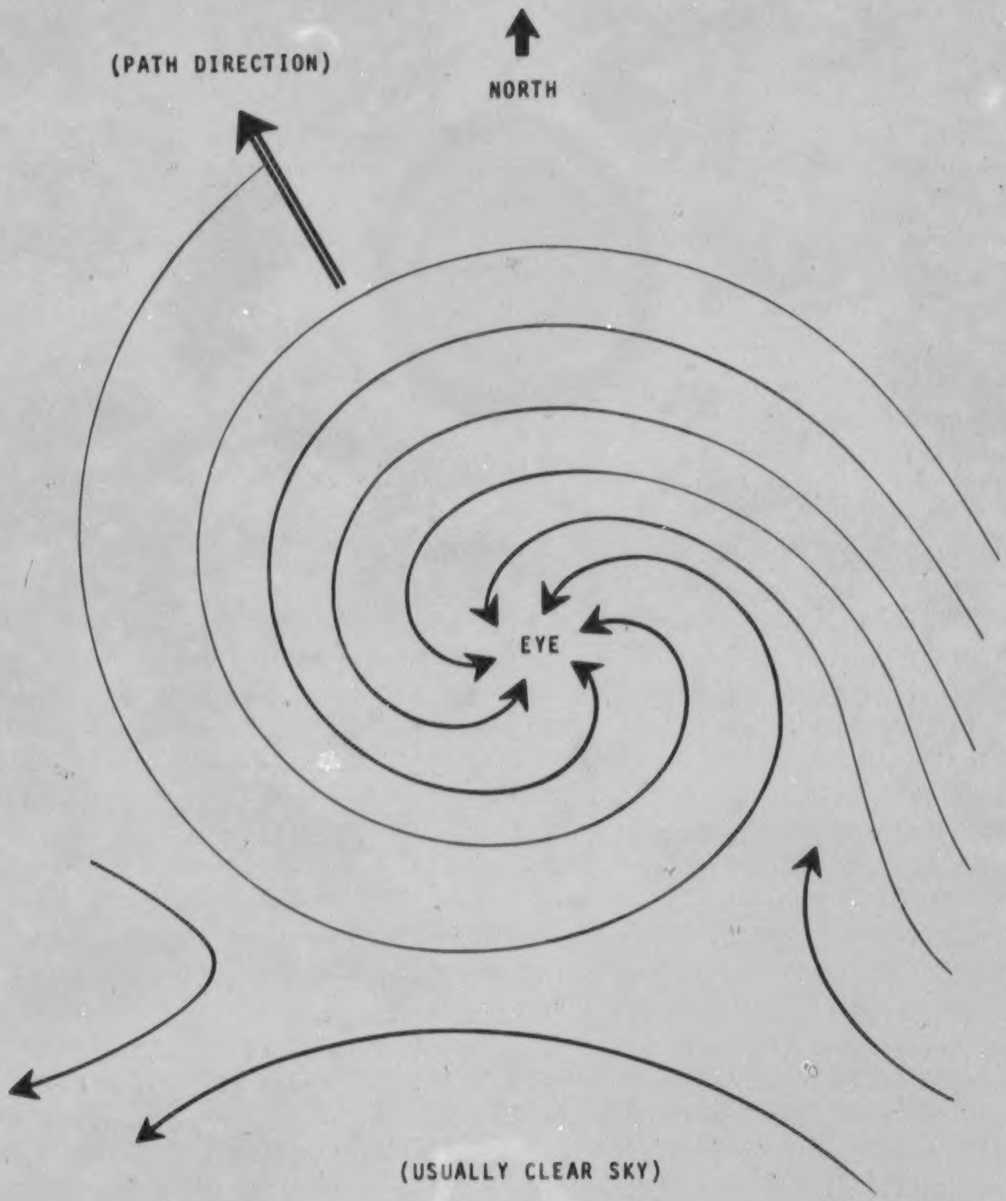

(PATH DIRECTION)
NORTH
EYE
(USUALLY CLEAR SKY)

Figure 2.11 Wind Flow Patterns Around Eye of Hurricane

Dynamic loads acting on the building introduce the additional variable of building mass. Modeling is usually accomplished by lumping at the floor level the dead weight of the floor slabs plus the tributary weight of all columns, window walls and partitions. This model is used in almost all building studies even though analytical techniques do exist for rationally representing the mass properties of all structural components. The lumped mass model is used because it enables one to write more efficient computer programs and because the error introduced by such a model seems to be acceptable in light of other uncertainties in the response problem.

Recognizing that the hazards considered herein induce lateral loading, it is important in analyzing the structure to clearly distinguish between the vertical load resisting elements and lateral or horizontal load resisting elements. The considerations involved are discussed in detail in Chapter 3.

Two structural characterization considerations which are attracting considerable earthquake engineering research effort at the present time are (1) soil structure interaction and (2) torsional building response. The soil structure interaction problem is discussed in reference [2.8]. At the present time there exist two general areas of discussion and research. The first involves modeling of the subsurface soil-building system. Finite element techniques exist for modeling building foundations with irregular geometric shapes and arbitrary soil strata. However, these methods do not prove completely adequate in the representation of the far field boundary conditions. Continuum mechanics solutions can very nicely model the radiation damping aspects of the problem but prove to be inadequate for arbitrary irregular basement and common boundary conditions. While it may be possible to reconcile a common soil-structural interaction approach, any such attempt at this time seems premature because to date the amount of available full scale information from past earthquake experience is not sufficient to prove or disprove any of several commonly accepted approaches.

The torsional response of buildings during earthquake and wind excitation has been observed [2.9]. This torsional response results from two sources. First, if a building has an irregular floor plan such that the building center of mass and center of stiffness do not coincide then translation loading components will produce torsional floor response. Moreover, since little is known about the damping present in torsional modes of vibration it may also be that even for symmetric buildings differences in damping values for the various modes may produce torsional floor motions. The second source of torsional response is the loading itself. This loading takes the form of a twisting component of ground motion [2.9] for the earthquake problem and a floor story torque for wind forces. While analytical modeling techniques exist for representing the three dimensional stiffness and mass characteristics of a structure, further research remains to be done using full scale test results before the loading and modal damping coupling can be adequately characterized.

At the present time, a consensus does not exist regarding the manner in which these effects should be accounted for in design. Neither effect, therefore, was included in the methodology presented herein. An approximate procedure for considering the forces resulting from the torsional moment associated with buildings having an irregular floor plan has been included in the Approximate Analytical Evaluation Method (Section 3.3 page 3-36). It is reasonable, to expect, however, that it will only be a short time, perhaps 5 to 10 years, before a consensus of opinion can be reached on how these factors can be incorporated in design and damage evaluation. It would then follow that their inclusion in the methodology presented would become appropriate.

2.4 BUILDING RESPONSE ANALYSES

The response of the building is obtained using either a static or a dynamic analysis. A static response analysis is common in wind, tornado, and hurricane problems wherein the dynamic character of the response is usually incorporated via a gust factor. This gust factor is usually dependent upon such dynamic parameters as fundamental building period and damping. This factor multiplies mean static loads to obtain a design loading for static analysis. In earthquake response studies a static response analysis is used when one uses the procedures recommended by most codes.

A nonlinear static analysis is possible with existing analytical technology; however, due to the uncertainties in the building and loading parameters, it is not commonly utilized in practice.

There are two basic choices available to the engineer when using a linearly elastic dynamic analysis procedure. One choice is hereafter referred to as the Modal Analysis Method and the other is referred to as the Direct Integration Method.

Either static or dynamic analyses may be used in connection with the evaluation procedures described in Chapter 3.

The modal analysis method involves the calculation of the natural periods and mode shapes of vibration of the building. These dynamic response parameters enable the engineer to mathematically define a set of distributed coordinates which characterize the deformed shape of the building. These distributed coordinates are usually referred to as normal mode coordinates and experience indicates that whereas many hundreds or perhaps thousands of physically identifiable discrete coordinates at the junctions of beams and columns may be necessary to specify the deformed shape of the building a significantly smaller number of distributed coordinates can be used to define the approximate deformed shape of the building within acceptable engineering accuracy. Mathematically, the discrete coordinates are obtained using a matrix transformation of the normal coordinates.

The primary motivation for using distributed normal mode coordinates in building dynamics is that when cast in this way, the dynamical equations of motion for the building are uncoupled second order differential equations identical in form to the equations of motion obtained for a simple single degree of freedom oscillator. Therefore, the building's dynamic response is expressed as the summation of a weighted series of single degree of freedom oscillator responses. Moreover, physically understood terms that are appropriate for single degree of freedom system description (e.g., natural period of vibration and percent critical damping), are also description parameters for the building problem. This extension of single degree of freedom concepts to the solution of a complex building's response enables the engineer to retain a physical feeling for the problem (i.e, engineering insight) and it is this factor that primarily accounts for the wide usage of the mode analysis method. Parenthetically, it is noted that this engineering insight enables an engineer to verify at intermediate steps in the solution process the numbers generated by the computer program and therefore, he can have more confidence in the accuracy of the computer generated answers.

The modal analysis method offers the engineer two analysis options - a response spectrum or a time history solution. A response spectra solution in the earthquake problem requires as input the response spectra of building base motion. The time history input requires an acceleration versus time history of base motion.

The direct integration method involves a straightforward numerical solution of the matrix dynamic equation of motion at each instant in time. In this method the building's natural periods and mode shapes of vibration are not calculated.

While modal damping must be specified in the modal analysis method, the direct integration method requires the specification of a complete system damping matrix. In practice the latter is usually estimated from test data using modal response.

The calculation of the nonlinear dynamic response of a building can be accomplished in a straight forward manner using step-by-step solution techniques as has been demonstrated by many authors. However, at the present time there appears to be two significant drawbacks to the widespread application of such nonlinear response algorithms. First, dynamic tests on full-scale structural components have not been numerous and there exists considerable uncertainty in the dynamic behavior of actual building components under earthquake type excitations. One can expect significant advances in this area in the next few years. Second, the financial expense of performing a nonlinear dynamic analysis on buildings can be great. Unless the building under consideration is a special structure for which a significant amount of money is allocated for a dynamic analysis, the engineer cannot afford to perform such an analysis.

2.5 NATURAL HAZARD DAMAGE EXPERIENCE

It is expected that buildings will experience damage when they are subjected to extreme natural forces such as those resulting from earthquakes, hurricanes, and tornadoes. There are exceptional cases in which buildings should not sustain damage such as nuclear reactor facilities. Damage to such buildings are not considered herein. In this section types of damage observed in past natural disasters which are most likely to occur are presented.

There is a fundamental difference in the way in which lateral loads are transmitted to a building from earthquake and from wind. In the case of earthquake, the load is transmitted to the building from its base. Thus, the entire building as well as the building contents will experience the force. In general, the magnitude of this force which individual members experience is proportional to their mass. On the other hand, in the case of wind, the load is transmitted to the building through its envelope. Thus, the cladding and its supporting members experience the initial effects of the wind load. Except for the structural members, the interior of the building including its contents will not experience the wind loads directly as long as the envelope remains intact. Therefore, the damage a building will sustain from these two natural events is different. In the remainder of this section, damage resulting from earthquake and wind is discussed separately.

Building Damage due to Earthquake

Current building codes anticipate that damage will occur to buildings when subjected to severe earthquakes. While not specified in the main body of the code, the intent of the seismic provisions in the present codes are to provide adequate resistance so that:

1. No damage would be sustained by the building in minor earthquakes,
2. No structural damage, but minor nonstructural damage would be sustained by the building in moderate earthquakes,
3. Structural damage as well as nonstructural damage would be sustained by the building without collapse in severe earthquakes.

Since a moderate earthquake is considered to be about a Richter magnitude of 4.0, any earthquake greater than this level would be expected to cause damage. The extent of damage, in general, is dependent on the building's dynamic characteristics, strength, durability, and stiffness. Damage experience in the past has shown that buildings deficient in any one of these have suffered severely. In addition, nonsymmetrical disposition of lateral load resisting systems could lead to an unfavorable response of the building, thereby inducing severe damage. Nonstructural elements not securely attached to structural members also suffer damage when the building is shaken by earthquakes. The extent of damage to these elements is dependent on the type of connections and their strength and stiffness.

Moment-resisting unbraced frame structures are relatively more flexible than braced frame and shear-wall structures. Adequately designed structural members can undergo the resulting large deformations without severe damage. Nonstructural elements and the building contents may however suffer significant damage. Braced frame structures and shear-wall structures, on the other hand, are relatively stiff and less ductile than moment-resisting unbraced frame structures. If not adequately designed, these buildings can fail in a non-ductile manner. Because of their smaller interstory drift these structures may suffer less nonstructural damage.

The types of damage discussed above were well documented for the 1972 Managua earthquake. The Banco Central Building, a moment resisting unbraced frame structure, experienced very extensive nonstructural damage, while it suffered moderately severe damage to structural members. On the other hand, the Banco de American building, a shear wall structure, suffered extensive structural damage to shear girders which are a part of shear core providing the main resistance to lateral forces. This building being relatively stiff, however, suffered little damage to the nonstructural elements and its contents. Detailed discussions of the performance of these two buildings are given in reference 2.10.

In general, structural members in moment resisting frames that suffer significant damage are columns and the panel zone at beam-column joints. Most of the column damage occurs at the ends. In the case of concrete frame structures, crushing of concrete with buckling of reinforcing bars and diagonal tension cracks, are usual modes of failure (fig. 2.12). For steel frame structures, local buckling of columns is a usual mode of failure (fig. 2.13). Panel zone failures in concrete and steel frames in a past earthquake are shown in figures 2.14 and 2.15.

Shear wall structures tend to fail in a non-ductile manner. Columns, piers, and floors and roofs acting as diaphragms tend to be severely damaged. Cracks formed in these members are illustrated in figures 2.16, 2.17, and 2.18. Failure of concrete floor diaphragm under high shear force is shown in figure 2.19.

Bearing wall structures are also relatively stiff. In order for this type of structure to survive an earthquake, the walls must remain intact in the vertical position. Many unreinforced or inadequately reinforced masonry bearing walls have generally sustained severe damage. Total collapse of such masonry structures is not uncommon. A typical old masonry infilled concrete frame structure near collapse is shown in figure 2.20. A severely damaged masonry bearing wall is shown in figure 2.21.

In shear-wall or load-bearing structures, lintels and shear beams that link shear walls sustain severe damage when not adequately designed. An example of such a failure is shown in figure 2.22.

Since the damage to structural and nonstructural members is due to the lateral motion of the building during an earthquake, the magnitude of the resulting inter-story drift can be related to the level of damage a building might sustain. The inter-story drift is incorporated in the development of the damage evaluation methods presented in this report and is used as an index in determining the level of damage.

Damage to buildings may result from non-uniform distribution of stiffness in plan and discontinuity of stiffness of the building along its height. These cause torsional deformations in addition to the flexural deformations resulting from the earthquake motions. Structures falling in this category are those buildings having irregular shapes and large differences in stiffness between stories. When a relatively stiff portion of a structure is supported by a flexible lateral load resisting system, the structure responds to ground shaking like an inverted pendulum and the flexible portion sustains the most damage. This type of failure was observed in the 1971 San Fernando earthquake and is shown in figures 2.23, 2.24, and 2.25.

Nonstructural elements can significantly alter the expected performance of the structure. In the Venezuela earthquake of 1967, many failures of concrete frame structures were attributed to the unexpected forces produced in frame members resulting from partitions acting as stiff shear walls. Detailed discussions of structural failures resulting from this type behavior are given in reference 2.11.

Failure of nonstructural elements pose a threat to the occupants of the building. Falling partitions, light fixtures, shelving, and the like are very hazardous. Furthermore, debris piled in corridors and stair wells (fig. 2.26) would be a barrier to egress and a hazard in the panic conditions during evacuation of the building.

Building Damage due to Extreme Wind

It has been observed that properly designed and constructed modern buildings will stand up relatively well under extreme winds. There is no documented evidence that indicates a complete collapse of engineered multistory buildings in severe winds. To date, only three completed highrise buildings suffered severe damage to the structural frame. Two buildings in Miami, Florida were subjected to hurricane winds of 152 miles-per-hour in 1926 and were distorted severely [2.12]. The third one in Lubbock, Texas was subjected to estimated tornado winds of over 150 miles-per-hour in 1970 and suffered severe damage to the structural frame [2.13]. This building was displaced laterally to such an extent that many interior gypsum block partitions suffered extensive damage.

Structures that are highly susceptible to severe wind damage are one-or-two story industrial buildings with long-span roof, one-story pre-engineered structures and residential structures including mobile homes. Damage to these types of structures from high winds is well documented [2.13, 2.14, and 2.15]. Extreme local wind pressures, usually negative in character, are common causes of failures of building elements. Uplifting of roofs and separation of exterior cladding from the building are the results of extreme suction forces. Several examples of such failures are shown in figures 2.27 through 2.32. Damage to windows and other exterior cladding may result from missile impact of wind-born debris, such as gravel from the roofs of adjacent buildings and other objects such as building materials stored at a nearby lumberyard. Severe damage to glazing of a high-rise building from wind-born gravel in the Lubbock tornado is shown in figure 2.33.

It has been shown that proper anchorage of roof, exterior cladding and window frames, can substantially reduce wind damage [2.16]. The anchorage factor is considered in the evaluation of damage to these items in the damage evaluation methods. In addition, inter-story drift values are used in assessing partition and glass pane damage in shear as these are related to sway motion of the building.

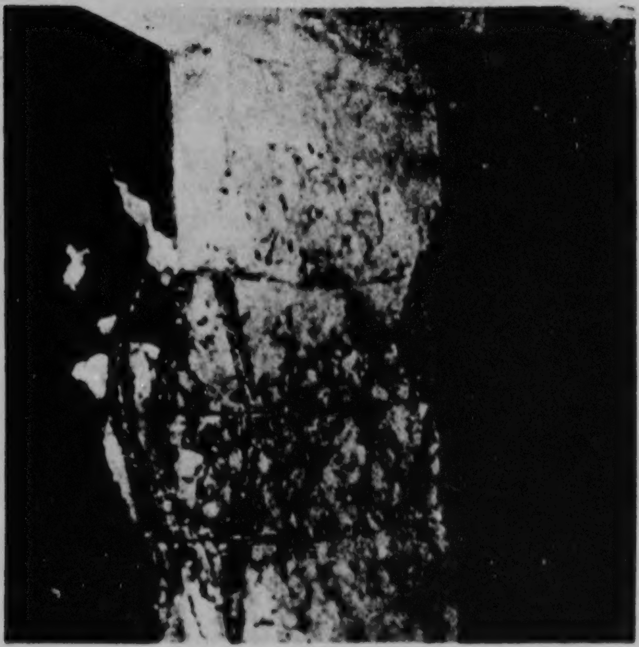


Figure 2.12 Compression Failure of Reinforced Concrete Column at Upper End.

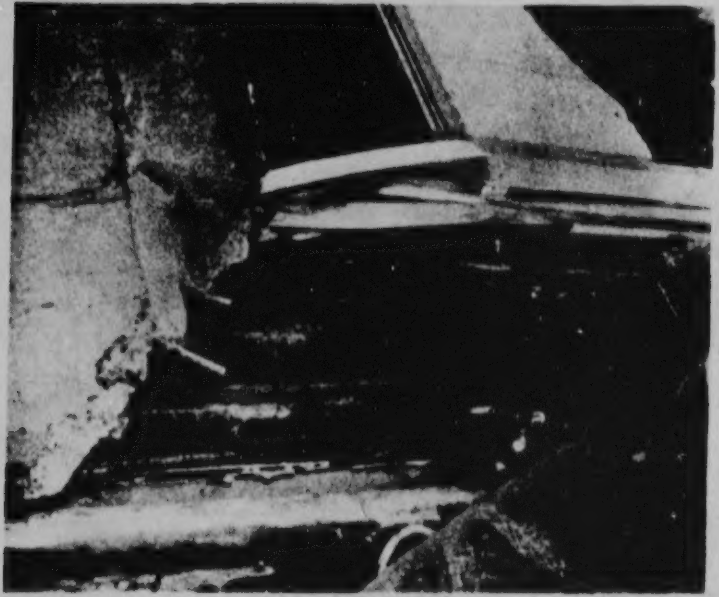


Figure 2.13 Local Flange Buckling of Steel Column at Upper End

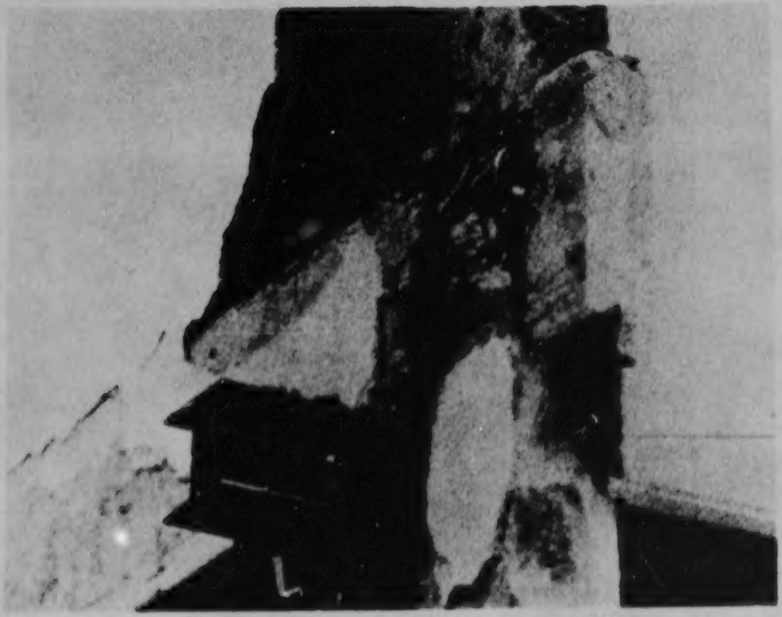


Figure 2.14 Failure at Beam-Column Joint of Reinforced Concrete Column

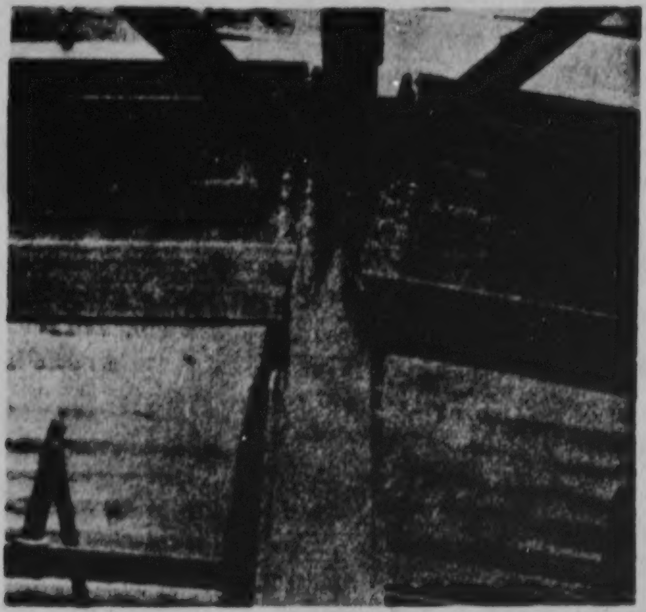


Figure 2.15 Failure of Panel Zone (Beam-Column) of Steel Frame

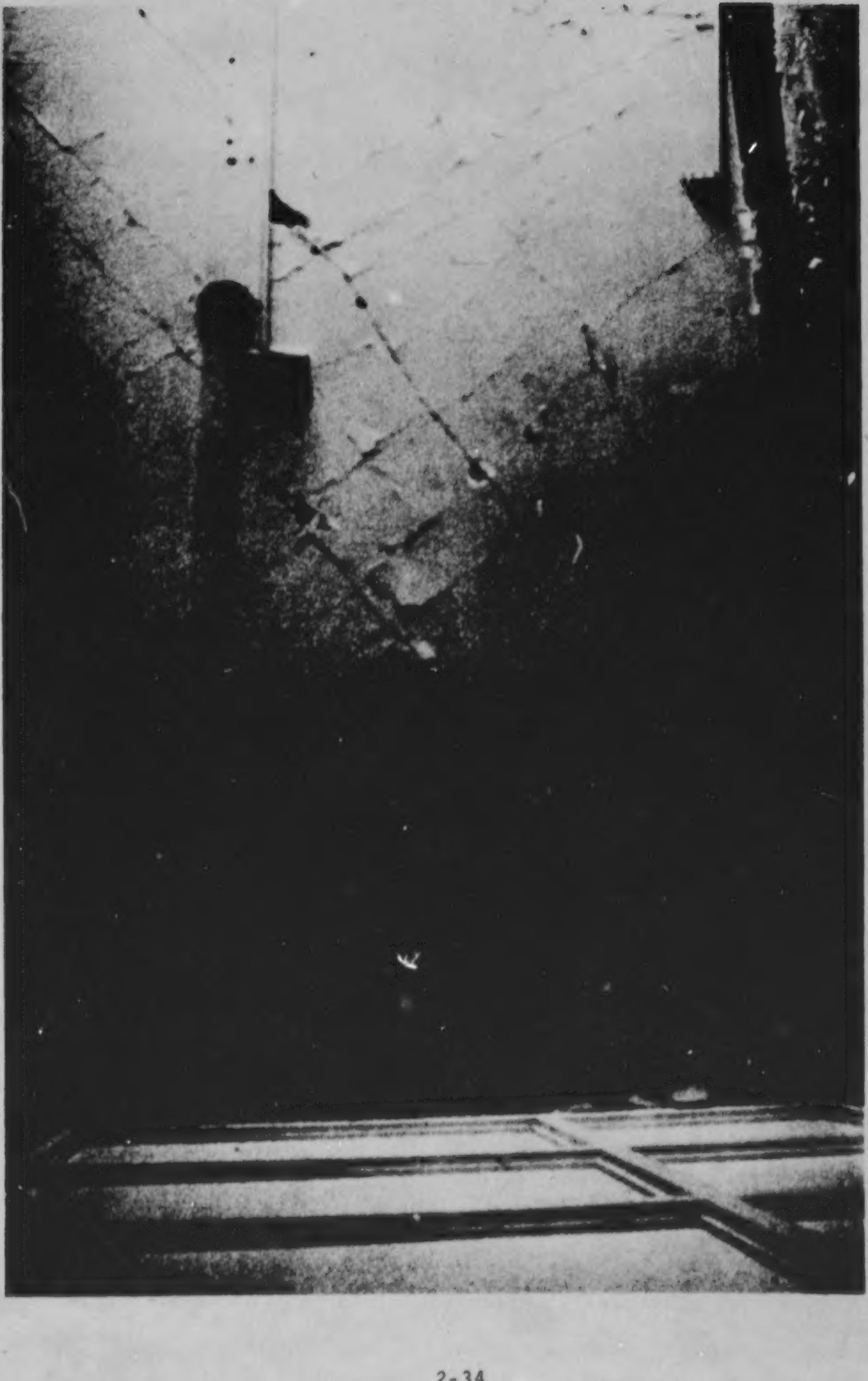


Figure 2.16 Diagonal Tension Cracks in Shearwall

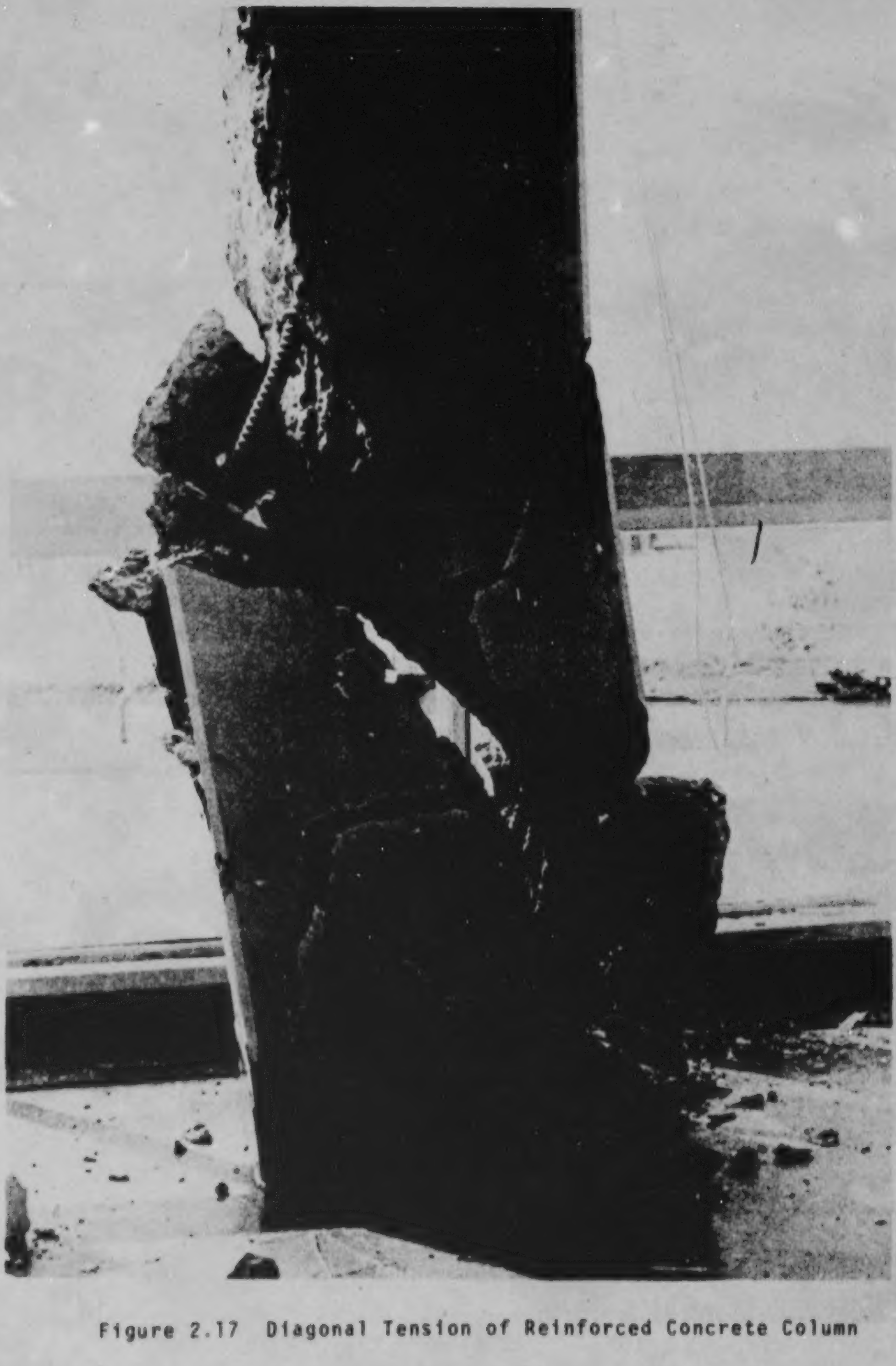


Figure 2.17 Diagonal Tension of Reinforced Concrete Column

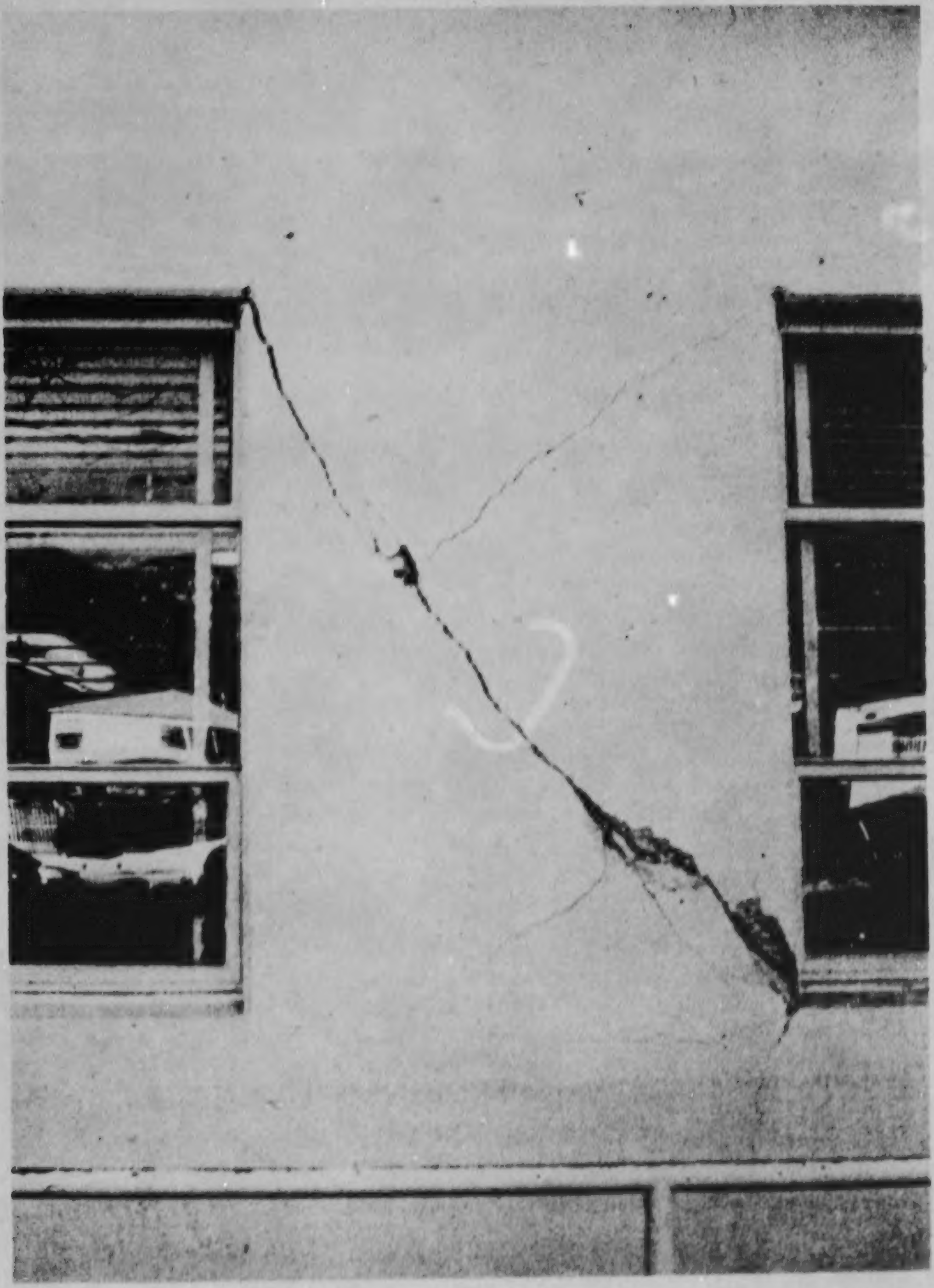


Figure 2.18 Diagonal Tension Cracks in Concrete Pier

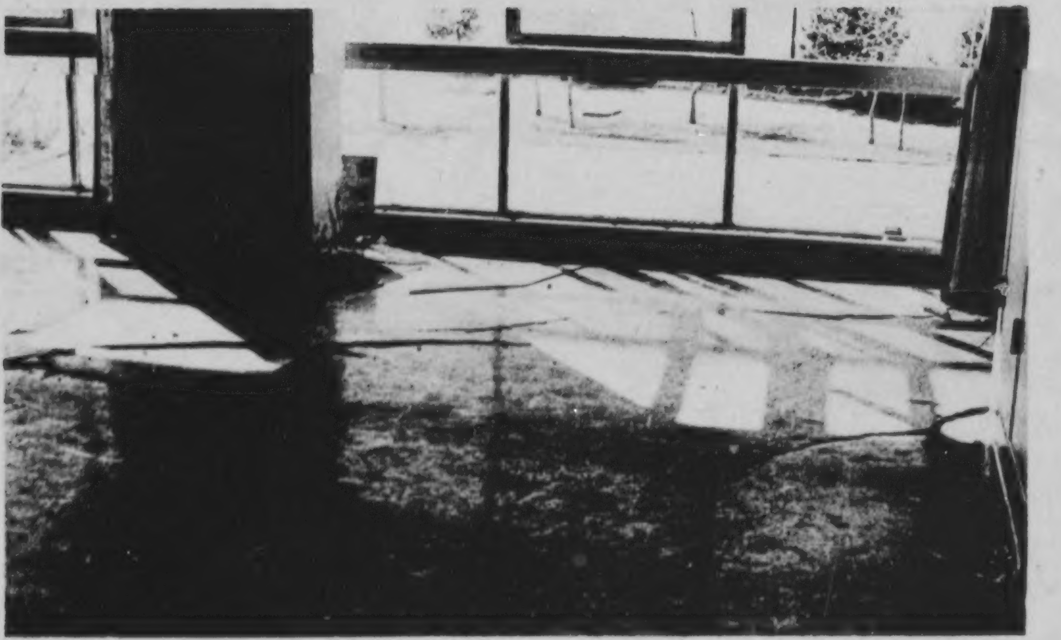


Figure 2.19 Failure of Concrete Floor Diaphragm

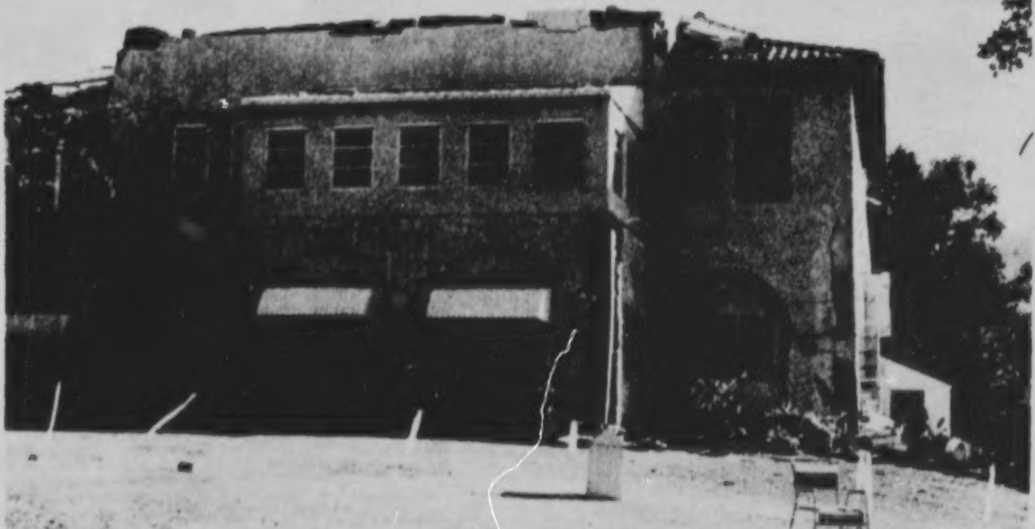


Figure 2.20 Severely Damaged Unreinforced Masonry Infilled-Wall Frame Structure

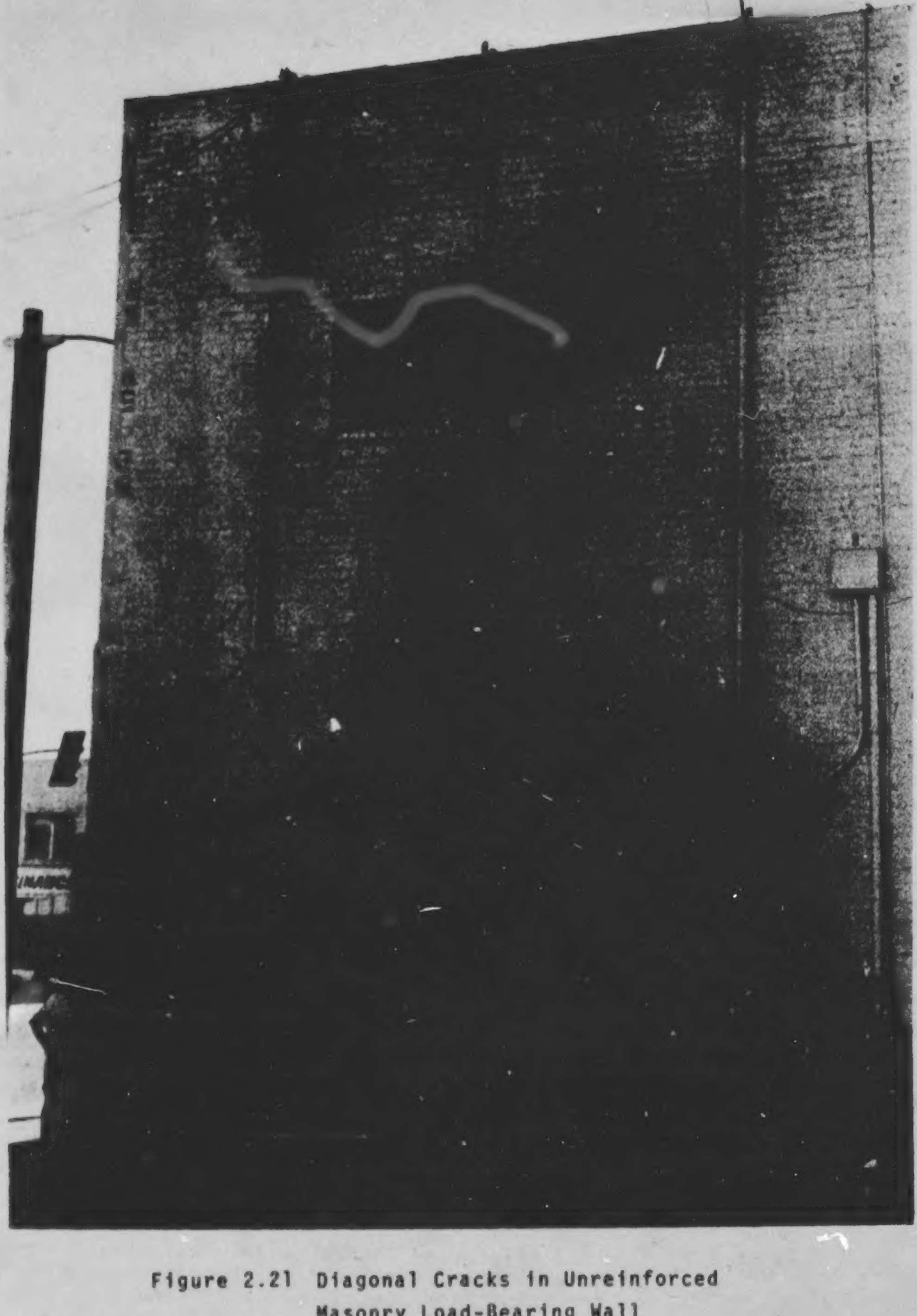


Figure 2.21 Diagonal Cracks in Unreinforced Masonry Load-Bearing Wall

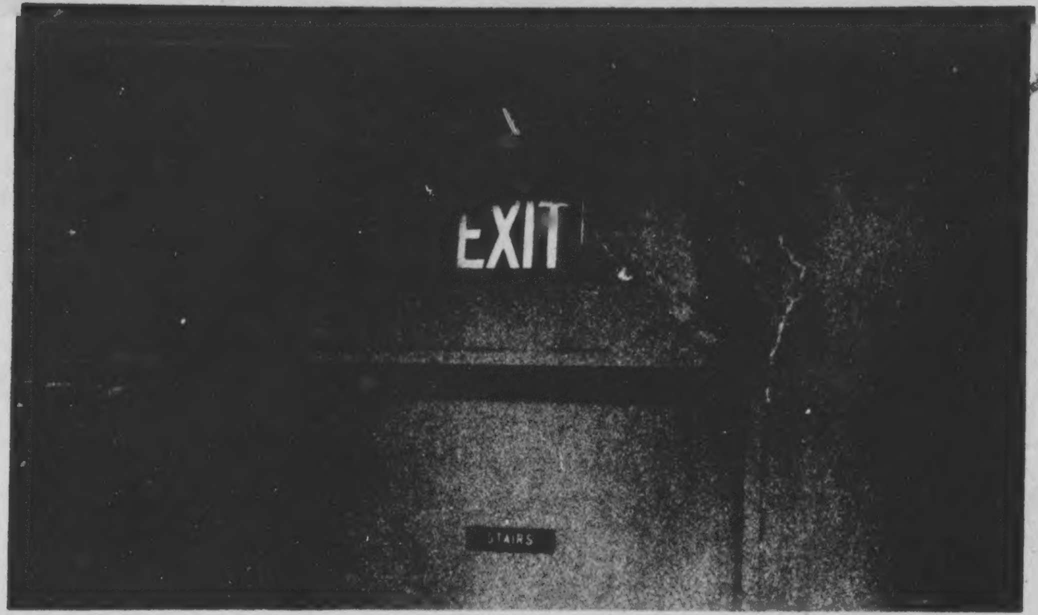


Figure 2.22 Failure of Door Lintel

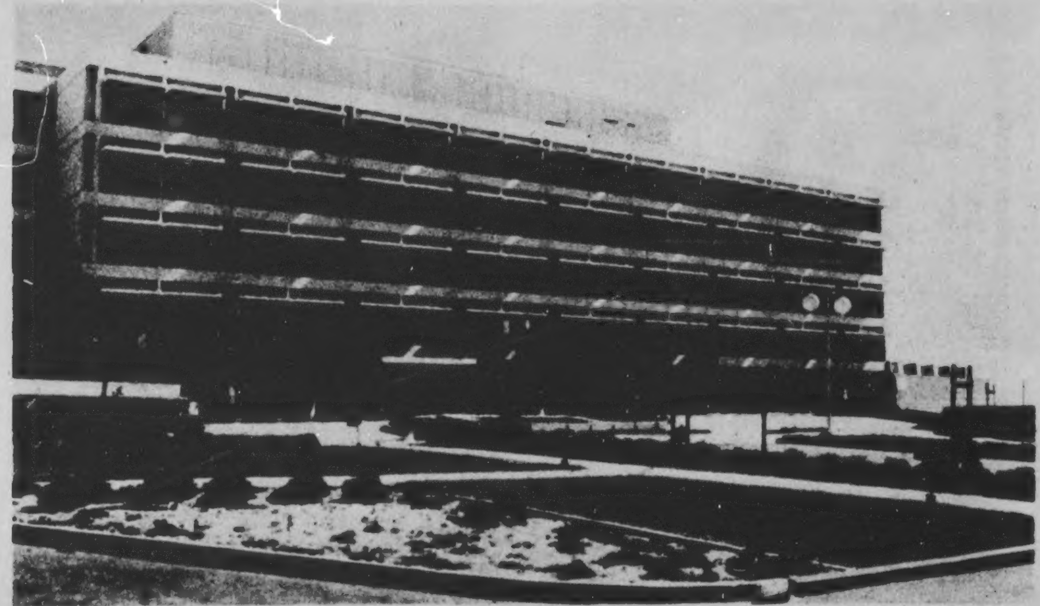


Figure 2.23 Damaged Reinforced Concrete Shear Wall-Frame Structure (Note Severe Lateral Displacement at the First Story Level due to elimination of Shear Wall)

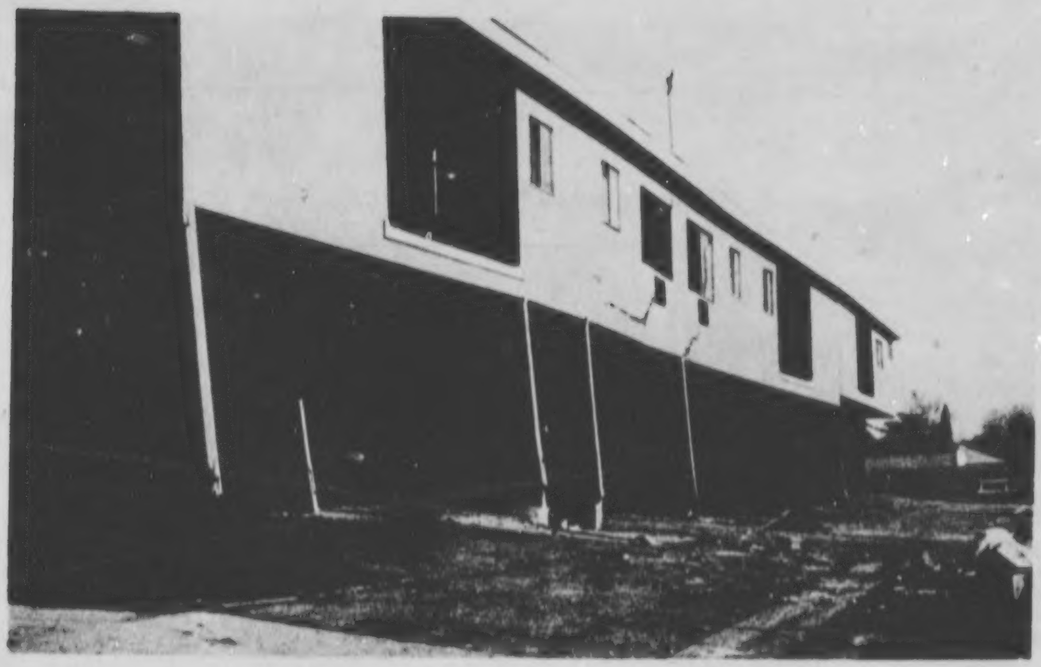


Figure 2.24 Distorted Light Wood Frame Structure

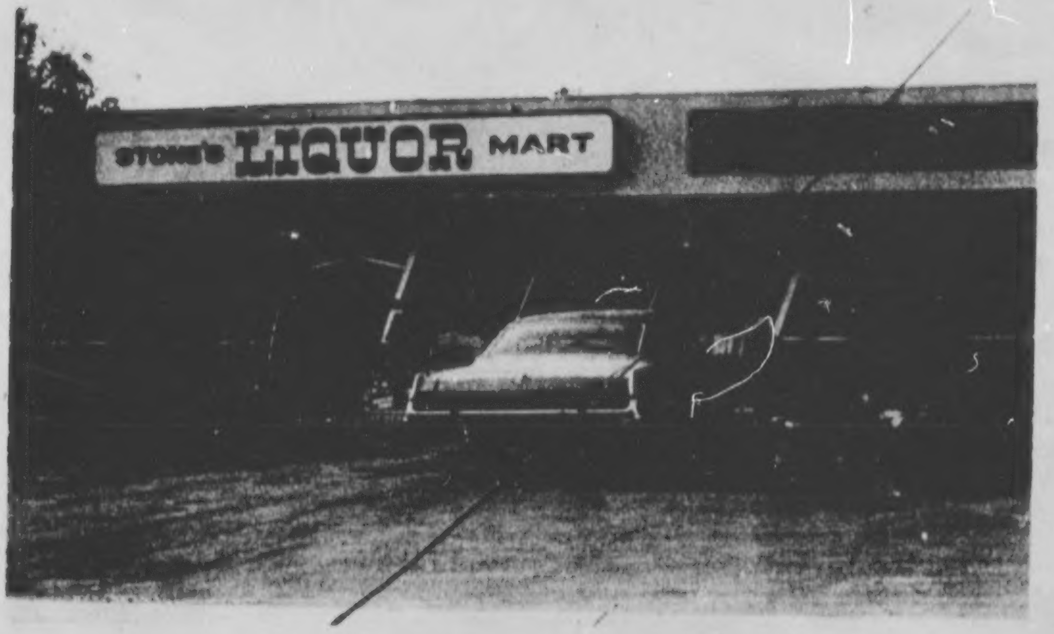

STONE'S LIQUOR MART

Figure 2.25 Distorted Steel Frame Structure

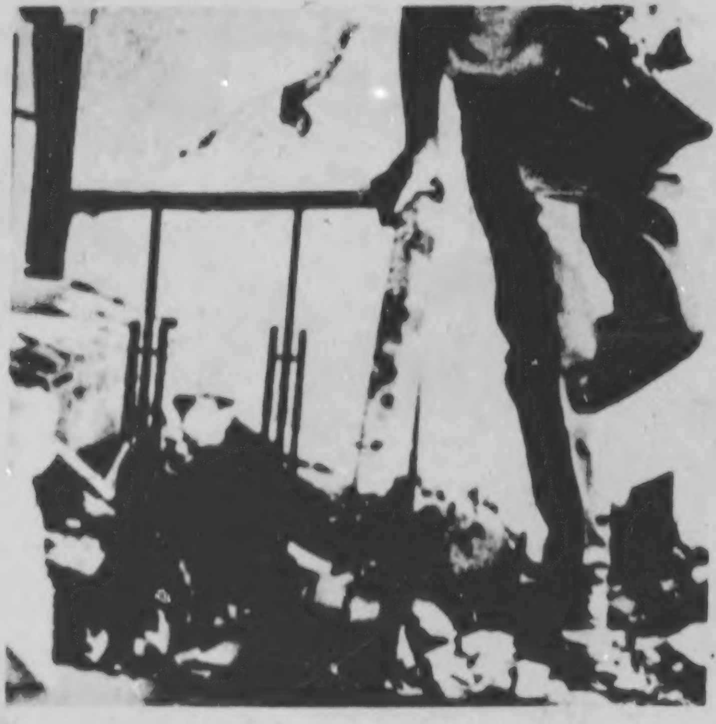


Figure 2.26 Staircase Littered with Debris of Enclosure Partitions

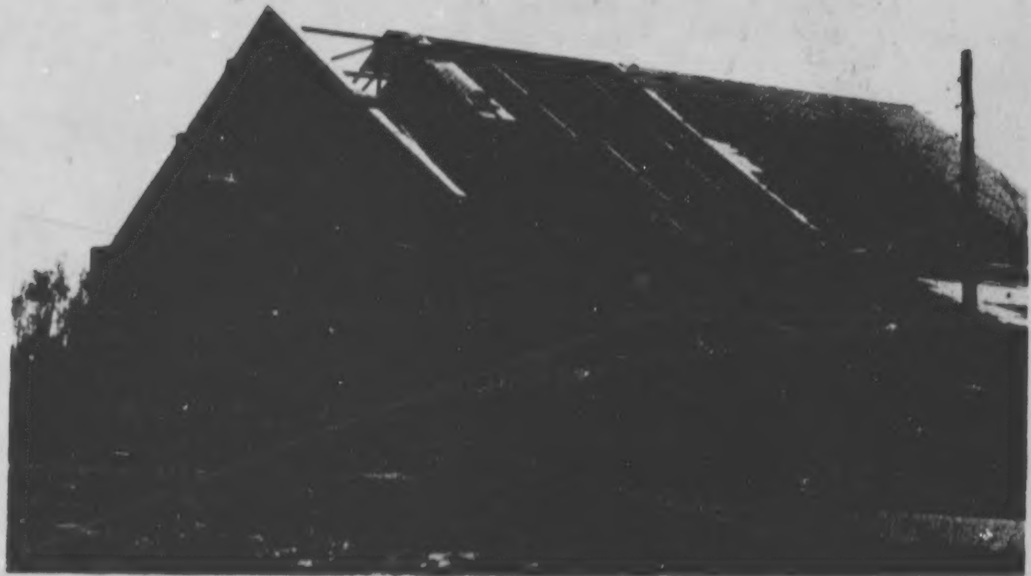


Figure 2.27 Partial Loss of Roof due to a Hurricane

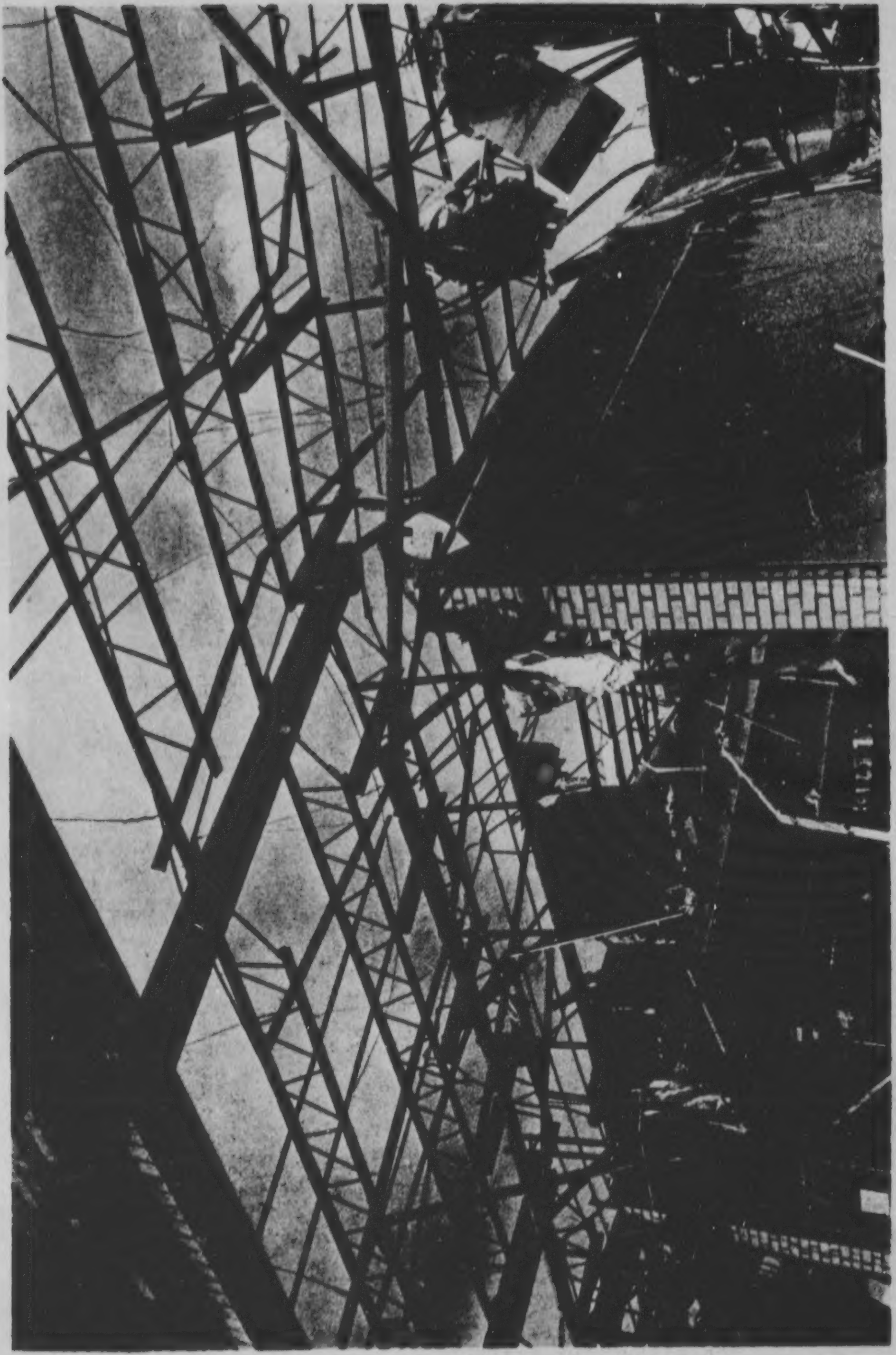


Figure 2.28 Total Loss of Light-Gage Steel Roof due to a Tornado

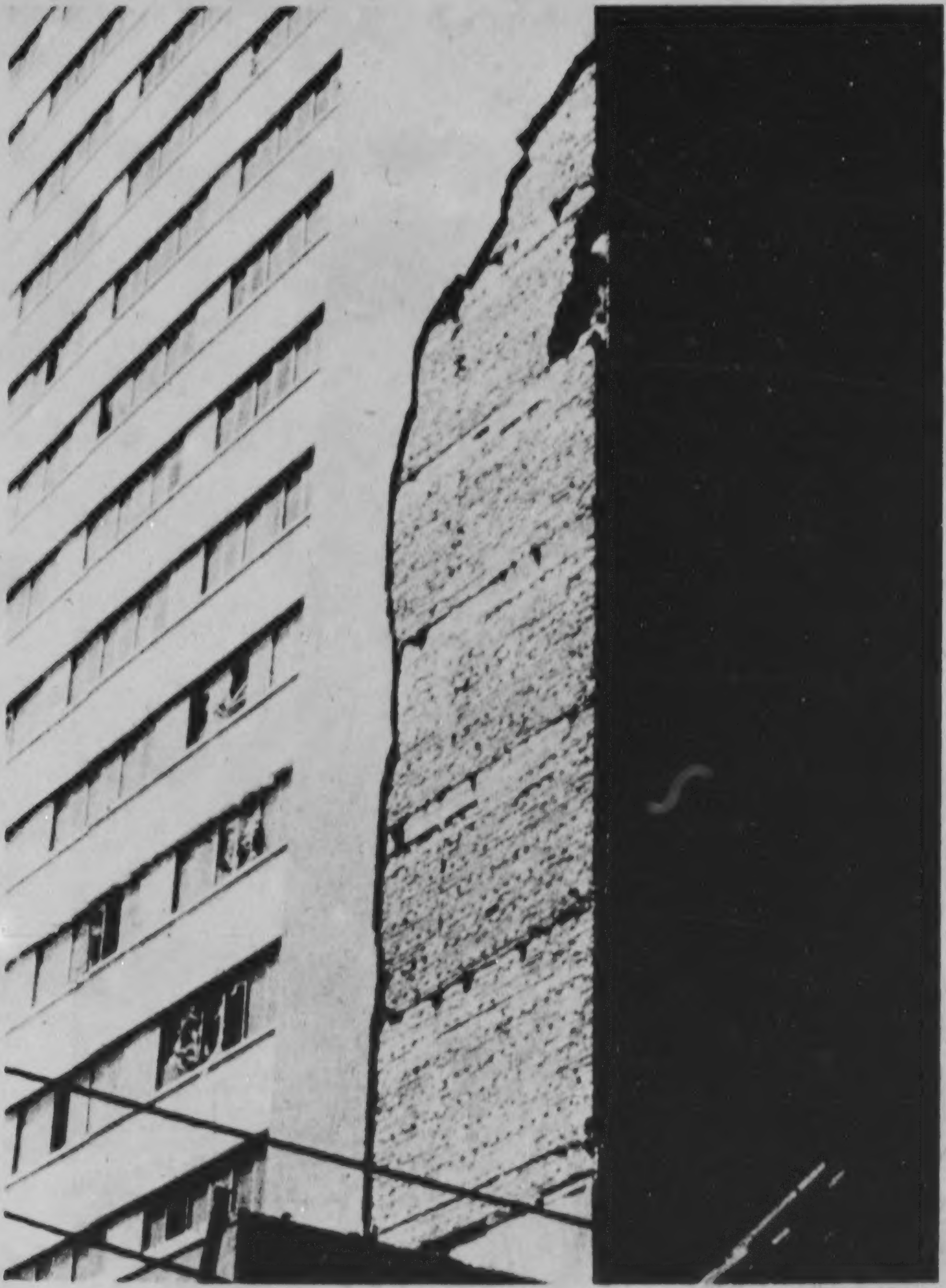


Figure 2.29 Damage to Exterior Brick Veneer due to Extreme Local Suction Pressure

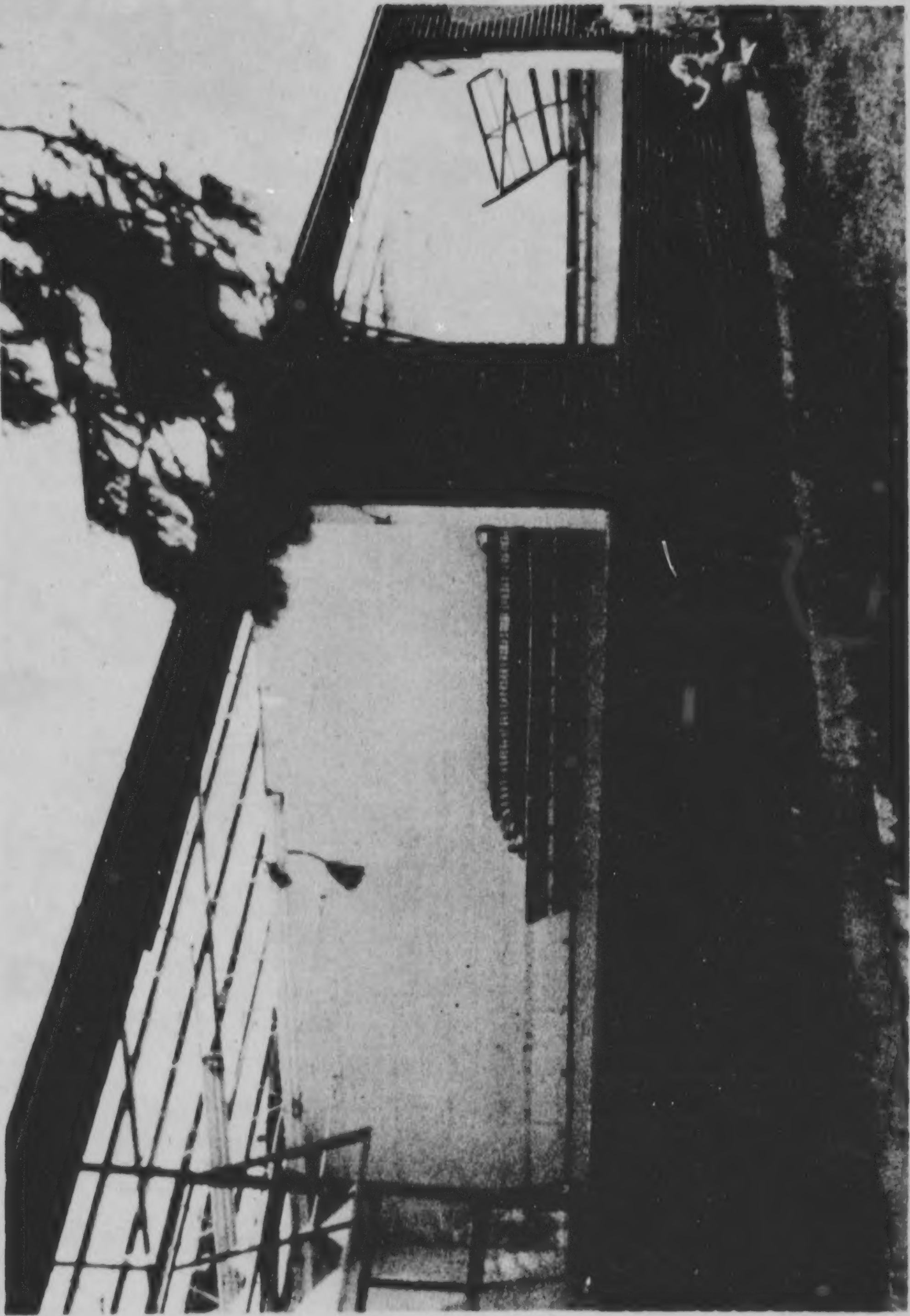


Figure 2.30 Total Failure of Window Casing

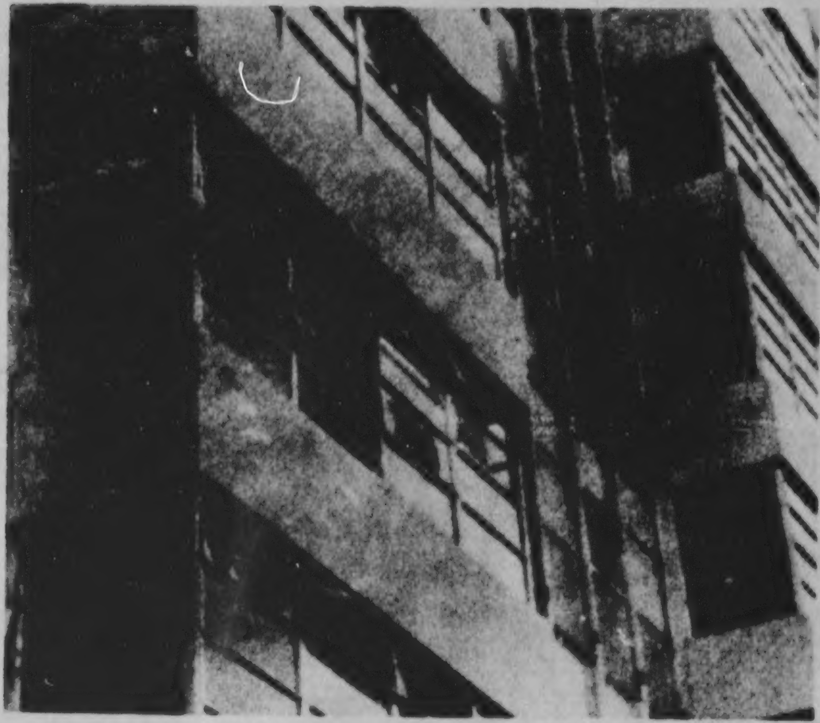


Figure 2.31 Window Damage at Corner of Building

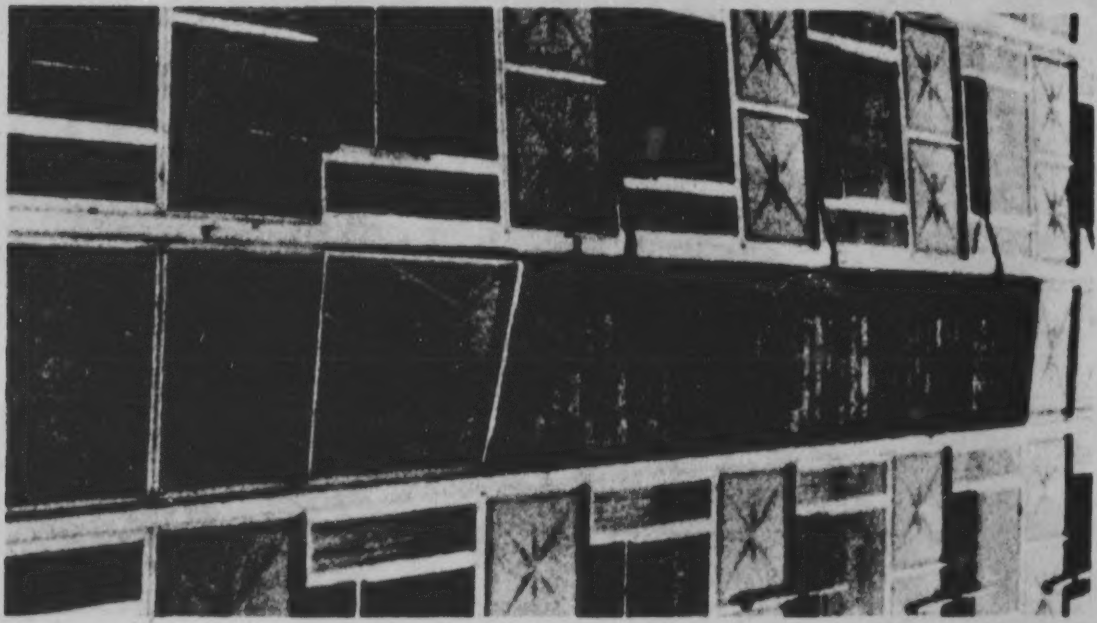


Figure 2.32 Wall Damage due to Local Wind Pressure

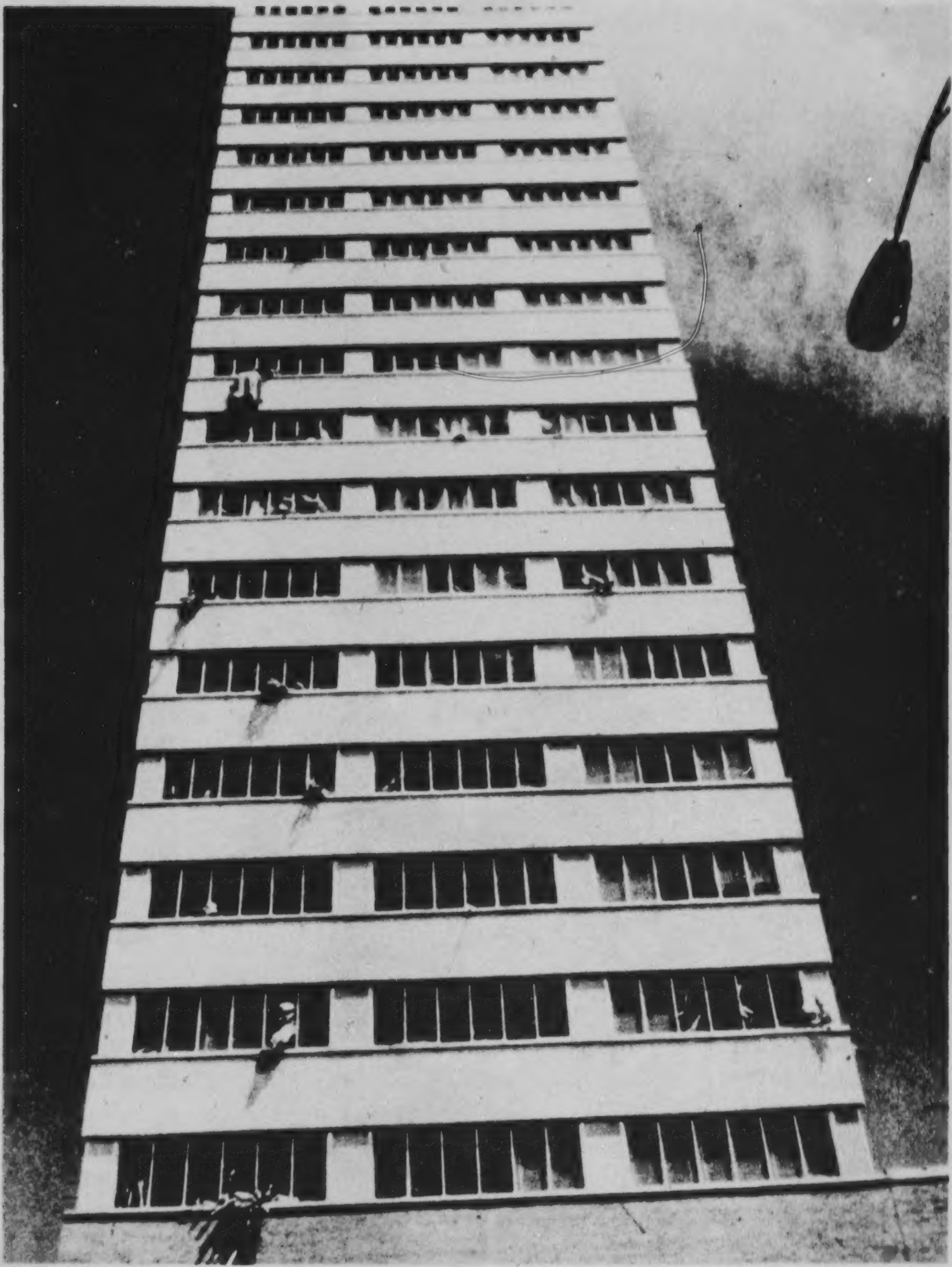


Figure 2.33 Glazing Damage due to Wind-Born Debris

3. DAMAGE EVALUATION METHODOLOGY

3.1 INTRODUCTION

This chapter presents a description of the three damage evaluation procedures included in the Damage Evaluation Methodology. Each procedure represents a different level of analytical sophistication. Each considers natural loading conditions encountered in earthquakes, winds, hurricanes and tornadoes. Existing historical seismic and meteorological data are used for determining the magnitude and recurrence interval for these hazard loadings. The types of structures considered include braced and unbraced steel frames, concrete frames, shear wall structures, combination frame and shear wall structures, bearing wall structures, and long-span roof structures.

The three damage evaluation methods are referred to as the Field Evaluation Method, the Approximate Analytical Evaluation Method and the Detailed Analytical Evaluation Method.

Section 3.2 outlines the Field Evaluation Method. In this method buildings are evaluated in terms of structural characteristics, structural configuration and the degree of deterioration of the building. A field survey of the building is used to gain information on these parameters. This method provides a rapid, inexpensive means for identifying clearly hazardous structures or potentially hazardous ones requiring a more detailed analysis to estimate damage. Chapter 4 presents an example of this method and Appendix B contains the procedures for using the method.

In the Approximate Analytical Evaluation Method, presented in section 3.3, buildings are evaluated in terms of the behavior of critical structural members. The procedure requires an analysis of the structure to identify critical members and determine the stress level induced in these members by the extreme environments. A set of building plans, specifications, and construction drawings are needed to obtain the necessary data required to perform the analysis. The method can be used to determine the damage level for buildings indentified by the Field Evaluation Method as requiring further analysis. Chapter 4 presents an example of the method and Appendix C contains the procedures for using the method.

In the Detailed Analytical Evaluation Method presented in section 3.4, the damage level is evaluated on the basis of the energy capacity of the structure. This procedure requires the use of a digital computer program for the evaluation. As in the Approximate Analytical Evaluation Method, the building data needed for input to the computer program would be obtained from a set of building plans, specifications and construction drawings. It is envisioned that this procedure would be used for more complex structures or critical facilities such as hospitals, communication centers, etc. Chapter 4 presents an example of the method. Figure 3.1 presents a schematic of the method which is used to evaluate buildings. The procedures for this method are given in Appendix E.

Prior to a detailed reading of this chapter, it is suggested that the reader examine the complete chapter to obtain an overall view of the complete methodology. Three items will be apparent from such an overall examination. First, each evaluation method can, in most cases, be conducted independently of the other two and hence is basically self-contained. Second, all three methods utilize professional engineering experience as expressed through codes. Of course, the Detailed Analytical Evaluation Method, because of its state-of-the-practice goal attempts to project beyond the present codes in many respects. Third, the amount and diversity of material for each method is considerable. The attempt was made, therefore, to present each method in such a manner that the user may read, study and master the methods one at a time. Some repetition of tables and figures was used with reader ease in mind and with the desire to reduce cross-referencing between sections.

Considering that there are three evaluation methods, a natural question to ask is, "Which method should I use for my building?" After studying the three methods it will be seen that for buildings which may be in serious danger, or for special structures of high public importance, a complete study should be performed. This involves use of all three methods. Each will provide valuable engineering insight into the potential forms and types of structural damage. While the detailed analytical evaluation method utilizes more state-of-the-art representation of loadings and matrix analytical modeling methods it is usually desirable to have this augmented by the feel for structural component performance obtained from the other methods.

The engineering time and cost is of course a function of the method selected. In general, the detailed analytical evaluation method will involve the most time and will provide the best prediction of damage. However, options exist within the computer program of the detailed analytical evaluation method which only require limited information and can be used for obtaining "ball park" estimates of damage.

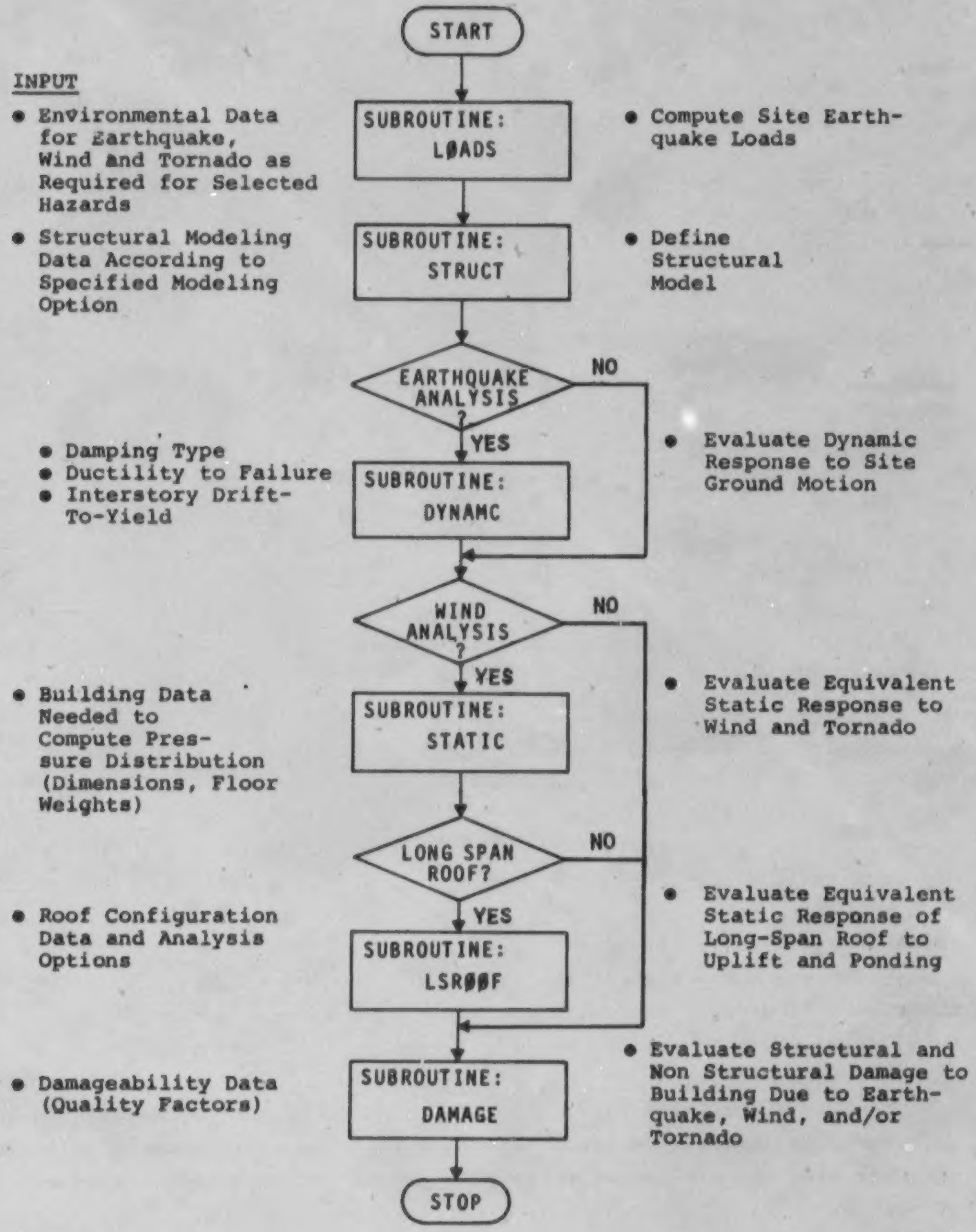

START
INPUT
• Environmental Data for Earthquake, Wind and Tornado as Required for Selected Hazards
SUBROUTINE: LØADS
• Compute Site Earthquake Loads
• Structural Modeling Data According to Specified Modeling Option
SUBROUTINE: STRUCT
• Define Structural Model
EARTHQUAKE ANALYSIS ?
NO
YES
• Damping Type
• Ductility to Failure
• Interstory Drift-To-Yield
SUBROUTINE: DYNAMC
• Evaluate Dynamic Response to Site Ground Motion
WIND ANALYSIS ?
NO
YES
• Building Data Needed to Compute Pressure Distribution (Dimensions, Floor Weights)
SUBROUTINE: STATIC
• Evaluate Equivalent Static Response to Wind and Tornado
LONG SPAN ROOF?
NO
YES
• Roof Configuration Data and Analysis Options
SUBROUTINE: LSRØØF
• Evaluate Equivalent Static Response of Long-Span Roof to Uplift and Ponding
• Damageability Data (Quality Factors)
SUBROUTINE: DAMAGE
• Evaluate Structural and Non Structural Damage to Building Due to Earthquake, Wind, and/or Tornado
STOP

Figure 3.1 Schematic of Program

3.2 FIELD EVALUATION METHOD

A. Introduction

The Field Evaluation Method can be used where evaluation results do not need to be as refined as would be expected from the other two methods. This method is particularly applicable if building plans are not available.

The purpose of the field evaluation is to determine the adequacy of the facility in question to resist the natural hazards of earthquake, wind and tornado that the facility may be subjected to.

The site will be assigned by the user an MMI intensity for earthquakes, a probable wind intensity and exposure and the probability of tornado occurrence. It may be determined that the possibility of a particular building being subjected to one of these natural hazards is so remote that it need not be evaluated for this hazard. The rest of the information necessary for evaluation of a structure by the Field Evaluation Method must be obtained from a field inspection or from plans (if they are available) or both. If plans are available, they should be checked in the field to see that they represent the "as built" condition. Data Collection Forms have been prepared for noting most of the pertinent items that will be required to fill out the rating forms for the building evaluation. The Field Evaluation Method is accomplished by completing the evaluations required on the FM forms. For assessing the earthquake hazard, form FMA-1 on the vertical resisting structural systems, form FMA-2 on the horizontal resisting structural systems, and forms FMB-1 and FMB-2 on non-structural items are used. For assessing the wind hazard, form FMA-1 and FMA-2 are used as for earthquake, FMC-1 is also used for the structural system, and FMC-2 is used for non-structural items. For assessing tornado hazards, Form FMD is used. A resume form FME is provided to indicate the overall capability of the structural system. For rating the structural systems, a 1 to 4 numerical rating is used. For non-structural items a letter rating of A,B,C or X is used. A copy of each of the forms noted in this section are shown in Appendix B and should be referred to for the following discussion.

B. Ratings of the Structural Systems - Earthquake and Wind (FMA Forms)

FMA Forms are provided for Field Evaluation Method ratings of the structural systems. Since earthquakes do not have a prevailing direction of motion, buildings are rated for their capability to resist lateral forces in the direction of each principal axis. Therefore, a separate rating is given for longitudinal and transverse resisting elements.

If there is little difference between longitudinal and transverse resisting elements, one of the ratings may be filled out and the other noted "Similar to ______." The horizontal resisting elements (diaphragms or horizontal bracing) in most cases will have similar ratings in both directions except where the diaphragms or bracing may not be complete between vertical resisting elements in each direction.

On Form FMA-1, "General Ratings (GR)" are assigned to the various types of framing in order to account for past performance and the degree of uncertainty that the building would perform in a manner anticipated for the type. These ratings are based on damage experience and judgment. For instance, it may be known that a building is a steel frame structure, but unless plans are available, it may not be possible to determine whether the beam-column connections are moment-resisting, or to what degree they are moment-resisting. In such cases it is suggested that the Type B rating be used. Similarly, in concrete where a visual inspection cannot determine the extent of reinforcement, it will not be known whether the frames are designed to resist moments and forces from horizontal motions. Type D is suggested for this case.

Wood stud walls may have various types of sheathing or combination of sheathing and plaster. For wood frame buildings of Type K, where plywood sheathing is used and is well nailed and blocked, a rating of 1 is suggested; otherwise, use the 2 rating.

The General Ratings for wind vary in some cases from those for earthquakes. Unless a building is very long and narrow, the total wind force acting on the building as a whole (except for tornadoes) is usually less than the earthquake force. In general, buildings of heavy construction in any area are less susceptible to wind than to earthquake damage when compared to buildings using light construction.

For masonry buildings of Type E, wind ratings of 2 or 3 are listed. As examples, if the masonry shear walls divide a building into nearly square areas, use the 2 rating. If a building is long and narrow, say 150 ft x 50 ft, with no interior walls that will act as shear walls, use the 3 rating.

For wood frame buildings of Type K, where it can be confirmed that there is well nailed and blocked plywood sheathing, use a wind rating of 2. Otherwise, use the rating of 3.

The column headed "Symmetry of Resisting Elements" describes the eccentricity between the center of mass of the structure and the center of stiffness of the vertical resisting elements. Thus, in a building where the only shear walls are the exterior walls with only one opening in the center of the opposite walls, and the building plan is rectangular, the building would be classified as Symmetrical. On the other hand, a two-story rectangular structure with nearly solid side and rear walls, but with a front wall almost entirely glazed with perhaps only four small piers or columns, would be classified as Very Unsymmetrical.

In the case of a multi-story building with a complete vertical load-carrying frame (i.e., without bearing walls), with columns uniformly spaced and reasonably uniform in size, a Symmetrical or Fairly Symmetrical classification would be given. Whether or not beams or girders frame into the columns with connections capable of taking significant bending moments may affect the symmetry. Portions of the building may have girders framing into columns in one direction with light beams or slabs framing to columns in the other direction. In such cases, the stiffness or rigidity of such bents would be greatly different and thus affect the symmetry. If plans are available, the symmetry can readily be determined; if not, best judgment should be exercised.

Symmetry can be greatly affected by location of mass. For instance, there may be only a partial third story over two full stories. This could produce dissymmetry unless the vertical resisting elements are correspondingly increased under this third story area.

Where rigid concrete floor, or roof diaphragms are involved, the effect of unsymmetrical vertical resisting elements is reduced, since such diaphragms can develop considerable torsion. For this reason, two rating numbers are provided for unsymmetrical systems - with the lowest number to be used where concrete diaphragms are present.

Some buildings have very rigid vertical resisting elements (such as shear walls) in the upper stories, but these are omitted in the lower story. This leaves only the columns and girders acting as a moment resistant frame for the horizontal resistance. A flexible first story such as this can create a dynamic response which could be very adverse and in a severe earthquake, could cause severe damage unless the design is based on an analysis considering dynamic response. Unless computations are available which show that this has been done, the Symmetry rating should be given a one point increase, but need not exceed 4.

The column headed "Quantity (Q)" refers to the number of vertical resisting elements. If there are many long shear walls this rating is 1. If there are so few shear walls that each is vital to resist lateral motions, the rating could be as much as 4. Intermediate conditions would have ratings between these extremes. One exception would be when shear walls occupy at least 75% of the exterior wall length, in which case the quantity rating would be 1 even though no interior walls are present.

In the case of moment-resisting frame structures of steel or concrete, both the strength and number of columns is important. For the usual case of multiple 20 ft to 35 ft bays, the Quantity rating would be 1. There are cases, however, where an entire building may be supported by only 4 large columns. In such cases the failure of one support would cause collapse. A Quantity rating of 4 would be appropriate. Similar reasoning would provide each building with its individual Quantity rating. In multi-story structures, the Quantity rating should be made for the worst condition in any story level.

Since Symmetry and Quantity values are interrelated and dependent on each other, a combined factor (SQR) will be used as a Sub-Rating. The SQR rating is the average of the Quantity rating and the Symmetry rating.

The columns headed by "Present Condition (PC)" is where wall cracks and other damage as described on the DC Form, see Appendix A, is evaluated. "Other Damage" may be damage caused by deterioration from lactic or tannic acid (frequently found in dairy or slaughterhouse facilities) or from severe popping of concrete caused by the use of reactive aggregates. The degree of damage in such cases can only be estimated by visual observation for the Field Evaluation Method ratings.

For vertical resisting elements consider "Quantity" and "Symmetry" combined as one factor and "Present Condition" as another factor with which a weighted average is found to produce "Sub-Rating (SR1)." This formula is based on experience. The procedure for finding the "Sub-Rating" is shown on Form FMA-1.

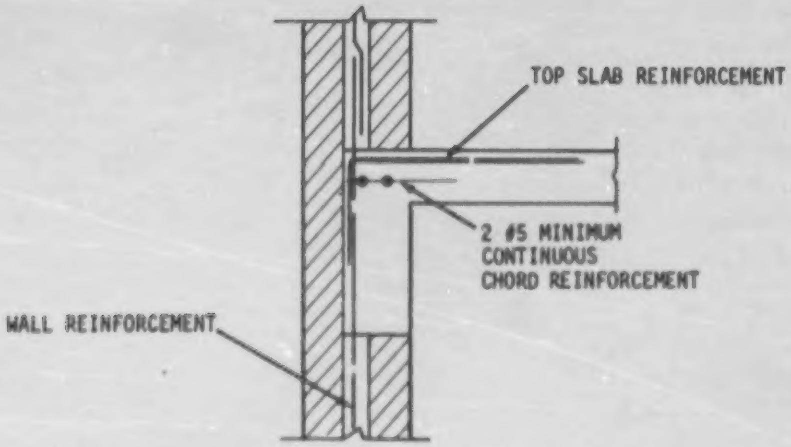
On Form FMA-2, horizontal resisting elements (floors or roofs) are evaluated. These are important elements in the capability of a building to withstand lateral forces. In earthquakes, the lateral forces originate at the centers of mass or weight. In the case of wind, the forces are usually applied laterally at the exterior walls and also with positive or negative pressures on the roof.

The floor or roof systems act as horizontal diaphragms to distribute horizontal forces to the vertical resisting elements, such as shear walls, moment-resisting frames, or braced frames. This diaphragm action is similar to that of a horizontal plate girder spaning between the vertical resisting elements and may be continuous over several supports. In this analogy the floor itself may be compared to the plate girder web, and the marginal beams or walls (chords) compared to plate girder flanges. The floor or roof system, acting as a girder web, is primarily a shear resisting element. The marginal beams or girder flanges (chords) in diaphragm action are primarily subjected to axial loads of tension or compression. Figure 3.2 shows examples of marginal concrete beams acting as chords. Wood, steel, or reinforced masonry beams also used where applicable.

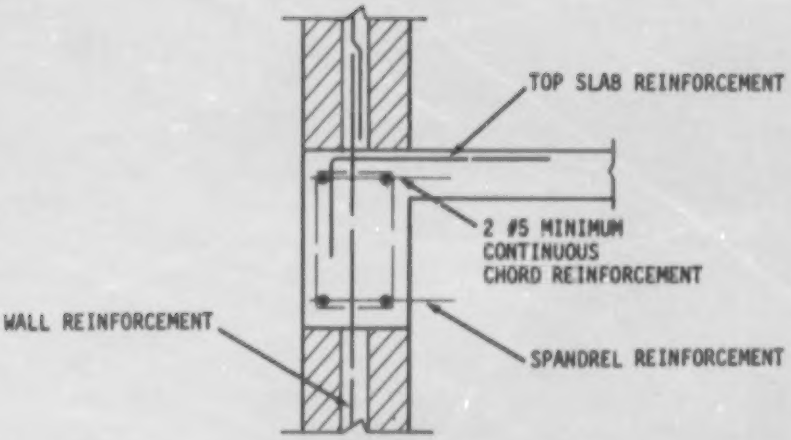
Shears are transferred by the anchorage between floor or roof and the shear walls or frame members. The DC form has spaces for describing these anchorage connections. The determination of the adequacy of anchorage or connections involves considerable judgment unless computations are made. The provisions of the local building codes may assist in this. If the date of construction of a building is known the applicable building code requirements of that data may be determined. If the governmental agency granting a permit had a good enforcement record at the time, it is probable that the anchorage details conform to the code requirements then in effect. There are areas, however, where there is or has been very little building code enforcement in the past. In such cases, conformance with code requirements applicable at the time of construction may be very questionable and greater dependence on visual inspection is necessary.

Where the floor or roof systems are of cast-in-place concrete and are placed integrally with portions of the shear walls or frames, generally a good anchorage with shear transfer capacities can be assumed dependent on the concrete strength, concrete slab thickness and amount and anchorage or reinforcing steel. The rating given would be 1 or 2.

With metal deck systems, the diaphragm values are dependent on the deck configuration, attachment between units, gage and attachments to supports. Where a structural concrete topping slab is used, dowels or other connections to supporting and marginal members may be used. The welding pattern of deck to steel supporting members has a large influence on the shear capability of this type of deck, as well as the ability of the deck to transfer horizontal loads to vertical resisting elements or chord members. Screw-type connection of metal decks to steel supporting members are sometimes used in lieu of welds. Figure 3.3 illustrates some typical metal deck connections.

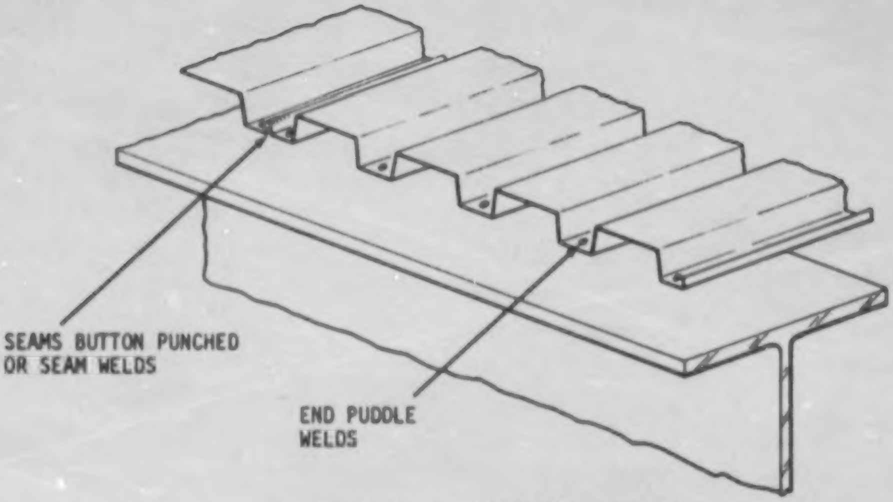

TOP SLAB REINFORCEMENT
2 #5 MINIMUM CONTINUOUS CHORD REINFORCEMENT
WALL REINFORCEMENT

DETAIL A

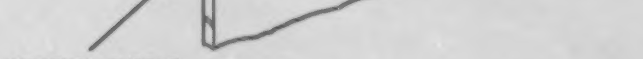

TOP SLAB REINFORCEMENT
2 #5 MINIMUM CONTINUOUS CHORD REINFORCEMENT
WALL REINFORCEMENT
SPANDREL REINFORCEMENT

DETAIL B

Figure 3.2 Typical Concrete Diaphragm Chord Details


SEAMS BUTTON PUNCHED
OR SEAM WELDS
END PUDDLE
WELDS

CONNECTION TO MARGINAL BEAMS


MARGINAL PUDDLE
WELDS

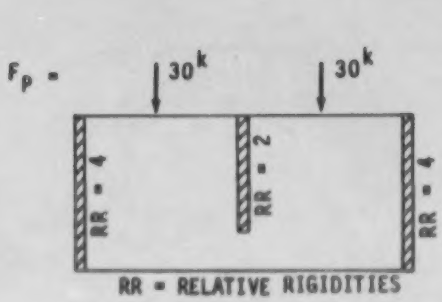
END CONNECTION TO SUPPORTING BEAMS

Figure 3.3 Typical Deck Connection Details

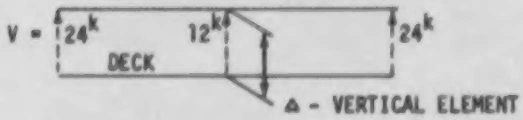
Where wood floor or roof systems are used as horizontal diaphragms, the connections to shear walls and frame elements is also very important. In areas where lateral force resistance is not required by code, there is a commonly used detail where floor joists or roof rafters are "fire-cut" into a masonry wall and anchored to the wall with a tee head self-releasing steel anchor, usually 5/8 in or 3/4 in diameter. This anchor has a 90° bend which is inserted into the side of the wood member. This is a good detail for fire hazard since it allows a burned joist to fall and pivot without pulling in the wall. However, this type of anchorage has very little value in transferring horizontal shear from floor to wall and is generally not accepted as a satisfactory earthquake resistant anchorage detail unless supplemented by other anchorage and shear transfer methods.

In many cases, it will not be possible to visually examine some of these connections and anchorage details. The plans, if available, may show these connection details. However, some clues may be available. For instance, the attic space may be accessible. If so, the connections of the roof to the walls may be seen with a flashlight. If the roof rafters are "fire-cut" into the bearing masonry walls and anchored with the T head anchors previously described, it is reasonable to assume that such walls are not reinforced unless there is real evidence to the contrary. Any information that can be obtained about the fastening of elements in the roof and floor system should be noted on the forms. The ratings on Form FMA-2 for "Anchorage and Connections (A)" are approximate, recognizing the difficulty in a thorough evaluation without calculations.

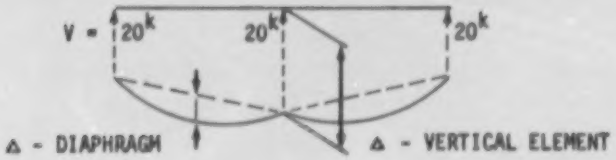
The flexibility of diaphragms is quite important. A rigid diaphragm will distribute horizontal forces to vertical resisting elements in proportion to the relative rigidities of those elements. A flexible diaphragm cannot do this and the distribution of lateral forces is therefore dependent on the masses tributary to the vertical resisting elements. The diaphragms, if very flexible, could be insufficient support for the wall elements, permitting the walls to fail as cantilevers. However, actual damage from lateral forces caused by flexible diaphragms has generally not been severe. For this reason the lower limit of 2.5 on the Rigidity Rating (R) has been used so as to reduce the importance of this factor in comparison with other factors in the overall rating. Figure 3.4 illustrates the relative effects of diaphragm stiffness on the distribution of lateral force to the vertical elements, e.g. columns and shear walls.


F_p =
30^k
30^k
RR = 4
RR = 2
RR = 4
RR = RELATIVE RIGIDITIES

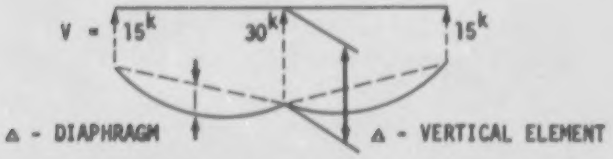
SCHEMATIC PLAN


V = 24^k
12^k
24^k
DECK
Δ - VERTICAL ELEMENT

RIGID DIAPHRAGM


V = 20^k
20^k
20^k
Δ - DIAPHRAGM
Δ - VERTICAL ELEMENT

SEMI-RIGID DIAPHRAGM


V = 15^k
30^k
15^k
Δ - DIAPHRAGM
Δ - VERTICAL ELEMENT

FLEXIBLE DIAPHRAGM

Figure 3.4 Relative Effects of Diaphragm Stiffness on Distribution of Lateral Forces to Vertical Resisting Members

For the Field Evaluation Method, where there will be no analytical evaluation, reasonable approximations must be made as to rigidity. The suggested classes of rigidity are as follows:

Rigid - Diaphragm of cast-in-place concrete.
Semi-Rigid - Metal deck diaphragms with structural concrete topping.
Metal deck systems made up of one fluted element and one flat element.
Pre-cast concrete elements with structural concrete topping.
Horizontal steel bracing.
Steel deck systems with insulating concrete fill.
Semi-Flexible - Well blocked and nailed plywood.
Double diagonal sheathing or straight sheathing plus diagonal sheathing.
Metal decks with fluted elements only.
Flexible - Unblocked plywood.
Diagonal wood sheathed floors or roofs.
Straight wood sheathed floors or roofs.
Corrugated iron roofing (screw fastened).

The existence of tension and compression chords for the diaphragm or horizontal bracing may or may not be easily determined by visual inspection. In the case of a steel frame industrial type structure with exposed roof, the steel members may be visible. In reinforced concrete buildings, a portion of the exterior concrete wall near the floor line can act as a chord if reinforced. There will probably be some horizontal reinforcing steel, but without plans the capacity of the chord is unknown. In such a case use a Chord Rating (C) of 2. In masonry walls known to be unreinforced, it is probable that no chord steel has been provided; in such a case use a Chord Rating of 3. In wood frame walls, where rafters or floor joists bear on a double plate, a chord can be formed by this double plate.

The Sub Rating (SR2) is assigned the highest individual rating as the individual ratings of horizontal resisting elements are independent of one another.

C. Rating of Other Life Hazards - Earthquake (FMB Forms)

Forms FMB are provided for the evaluation of life hazards originating from sources other than the basic structural systems. These ratings assess the individual element hazard only. For the purpose of this method, the following additional life hazards are considered:

Collapse of Exit Corridor or Stair Enclosure Walls.
Collapse of Other Partitions.
Glass Breakage.
Falling Exterior Appendages or Units of Wall Cladding.
Excessive Gas Leakage.
Falling Ceilings.
Falling Light Fixtures.

Collapse of Exit Corridor or Stair Enclosure Walls (FMB-1)

If exit corridors or stairs are enclosed by brittle, unreinforced masonry wall elements, the wall elements may become badly cracked in a severe earthquake, particularly those which are tightly enclosed by the structural frame. Sometimes they even appear to explode. This is the type of failure that can occur where earthquake motions are parallel to the walls. Where the earthquake forces are normal to the plane of the wall, the walls will tend to bend as a slab. If they are incapable of taking tension, they could fail in flexure. When walls are only of moderate height, the anchorage of walls to frame elements could be critical. Failure of the anchorage could allow a wall to topple over.

Where the exit enclosure walls are well reinforced, they may crack when subjected to severe earthquake motions. Because of the basketing effect of the reinforcing steel, collapse is much less probable. The risk of having a wall falling out to injure people or having debris clutter up the exit way is reduced. The same comments apply to unreinforced and reinforced concrete walls.

Exit way enclosure walls using metal studs and plaster may have some cracks, but there is a considerable basketing effect so that only small portions would tend to fall. Thus the life hazard risk is considerably less. The use of dry wall over metal studs forms a wall that can take some distortion. Some cracks may occur, usually at the dry wall joints and some fastenings may come loose. However, the life risk here is also comparatively low. The fastening and support of the top and bottom tracks is important so that the entire wall will not topple. Wood studs and plaster can take considerable distortion also and are considered in the low risk category as far as a hazard to occupants is concerned.

Collapse of Other Partitions (FMB-2)

The same comments apply here as to exit corridor or stair enclosure walls as to the causes of damage and type of damage expected. In buildings where the vertical loads are supported by a standard frame system, however, these "other partitions" are more likely to be non-bearing and removable. In many cases they will be supported by the floor below and attached to the ceiling but not to the structural floor above. The anchorages in both cases are important to the stability of the partitions during an earthquake. This is discussed under the "Falling Ceilings" hazard.

Glass Breakage (FMB-2)

Glass breakage can occur when the glazing and setting of the glass does not permit sufficient movement of the enclosing structural frame relative to the glass pane. For instance, if the story-to-story drift of a building were 1/2 inch and the glass pane were of a height equal to half the story height, a quarter inch of play in the glazing setting would be required. Otherwise the glass will crack. Most of the glass breakage during earthquakes is caused by forces parallel to the plane of the glass. This is in contrast to wind, where risk of breakage is a result of relatively higher normal pressure and glass may break in flexure.

The Uniform Building Code (1973 edition) as published by International Conference of Building Officials contains minimum glazing requirements, shown here in table 3.1 [2.5]. These requirements are reproduced as a guide to recommended hazard reduction requirements in areas where earthquakes are anticipated. If possible, the conformance to these provisions should be determined where glass windows and doors are so located that breakage could endanger life in public ways, exit corridors or stairs. Some typical details providing for drift are shown on figure 3.5.

Falling Exterior Appendages or Units of Wall Cladding (FMB-2)

Exterior appendages or wall cladding elements, unless properly anchored to the basic structure, pose a high hazard to life if located above a public way or other locations where people will normally congregate or pass. Exterior appendages may be architectural ornamentation of cast stone, precast concrete, or terra cotta. These are relatively heavy. On the other hand, some may be made of sheet metal and be comparatively light. Wall cladding may be heavy or light and composed of thin veneer or stone, clay products, or metal. The degree of hazard depends primarily on the anchorage which should be able to resist lateral forces or motions which are a function of the weight of the element, the flexibility of the frame, and the seismicity of the area involved. Both spacing and strength of anchors should be determined. See table 3.2 for a listing of the probable type of anchorages to be found for different wall cladding materials.

Table 3.1 MINIMUM GLAZING REQUIREMENTS

FIXED WINDOWS AND OPENABLE WINDOWS OTHER THAN HORIZONTAL SLIDING					
GLASS AREA	Up to 6 Sq.Ft.	6 to 14 Sq.Ft.	14 to 32 Sq.Ft.	32 to 50 Sq.Ft.	Over 50 SqFt
Minimum Frame Lap	1/4"	1/4"	5/16"	3/8"	1/2"
Minimum Glass Edge Clearance	1/8" [1,2]	1/8" [1,2]	3/16" [1]	1/4" [1]	1/4" [1]
Continuous Glazing Rabbet & Glass Ret.[3]	REQUIRED	REQUIRED	REQUIRED	REQUIRED	REQUIRED
Resilient Setting Material[4]	Not req'd.	REQUIRED	REQUIRED	REQUIRED	REQUIRED

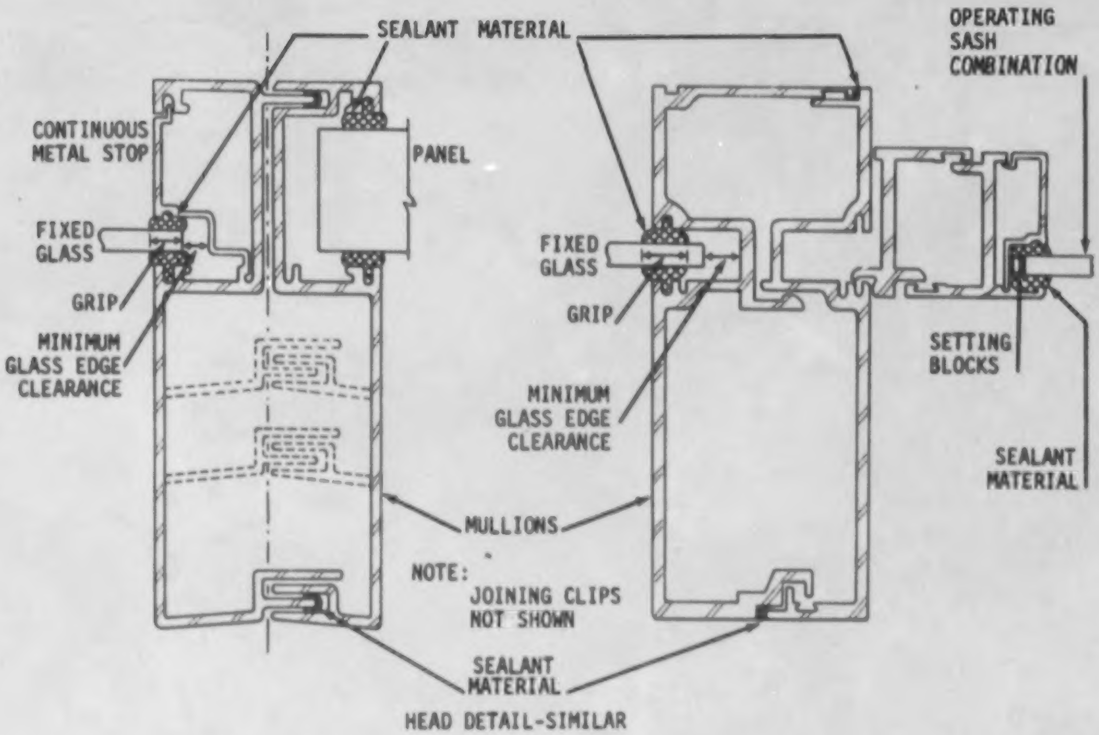
SLIDING DOORS AND HORIZONTAL SLIDING WINDOWS				
GLASS AREA	Up to 14 Sq.Ft.	14 to 32 Sq.Ft.	32 to 50 Sq.Ft.	Over 50 Sq.Ft
Minimum Glass Frame Lap	1/4"	5/16"	3/8"	1/2"
Minimum Glass Edge Clearance	1/8" [2]	3/16"	1/4"	1/4"
Continuous Glazing[3] Rabbet and Glass Retainer[3]	REQUIRED ABOVE THIRD STORY	REQUIRED	REQUIRED	REQUIRED
Resilient Setting Material[4]	NOT REQUIRED	REQUIRED	REQUIRED	REQUIRED

1. Glass edge clearance in fixed openings shall not be less than required to provide for wind and earthquake drift.

2. Glass edge clearance at all sides of pane shall be a minimum of three-sixteenths inch where height of glass exceeds three feet.

3. Glass retainers such as metal, wood or vinyl face stops, glazing beads, gaskets, glazing clips, and glazing channels shall be of sufficient strength and fixation to serve this purpose.

4. Resilient setting material shall incluce pre-formed rubber or vinyl plastic gaskets or other materials which are proved to the satisfaction of the Building Official to remain resilient.

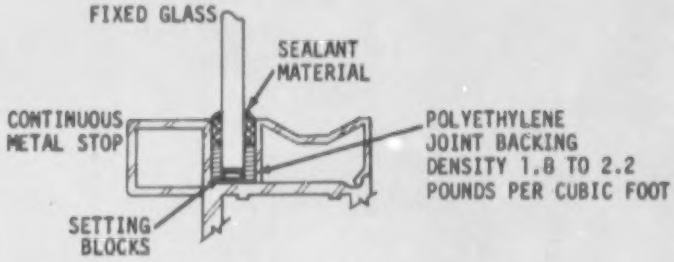

SEALANT MATERIAL
OPERATING SASH COMBINATION
CONTINUOUS METAL STOP
PANEL
FIXED GLASS
GRIP
MINIMUM GLASS EDGE CLEARANCE
FIXED GLASS
GRIP
SETTING BLOCKS
MINIMUM GLASS EDGE CLEARANCE
SEALANT MATERIAL
MULLIONS
NOTE:
JOINING CLIPS NOT SHOWN
SEALANT MATERIAL
HEAD DETAIL-SIMILAR

JAMB DETAIL A

MULLION WITH FIXED GLASS AND WALL PANEL

JAMB DETAIL B

MULLION WITH FIXED GLASS AND OPERATING SASH COMBINATION


FIXED GLASS
SEALANT MATERIAL
CONTINUOUS METAL STOP
POLYETHYLENE JOINT BACKING DENSITY 1.8 TO 2.2 POUNDS PER CUBIC FOOT
SETTING BLOCKS

SILL DETAIL C

Figure 3.5 Typical Window Details

Table 3.2 PROBABLE TYPES OF ANCHORAGE FOR EXTERIOR APPENDAGES AND WALL CLADDING

TYPE	WEIGHT CATEGORY	TYPE OF ANCHORAGE					
		Steel Rods	Dovetail Slots	Weldments	Adhesive	Bolts or Screws	Mortar only
Cast Stone or Stone	Heavy	X	X				X
Terra Cotta Thick	Heavy	X					
Terra Cotta Thin	Light	X			X		
Precast Cement	Heavy	X		X			
Marble Thin	Light				X		
Sheet Metal	Very Light					X	
Masonry Veneer	Heavy		X				

All of the above types of anchorage can be considered good if present and at close enough spacing and have adequate strength, except for the "Mortar Only" type.

Excessive Gas Leakage (FMB-2)

The breaking of gas lines during an earthquake can result in excessive leaks which would lead to serious fires or explosions. Special automatic gas shut-off valves have been developed for areas of high seismicity which, if used, would mitigate this hazard. Flexible type connections just outside a building are sometimes provided to minimize the risk of a rupture at that point. A typical specification for earthquake valves reads as follows:

> "Earthquake valves shall be furnished complete with remote manual control. This control shall be mounted in an acceptable location on the exterior of a building or meter enclosure 6 ft 0 in above grade and shall consist of continuous unspliced phosphor cable in galvanized steel screw pipe with brass roller elbows at each change of direction in the line."

The presence or absence of such connections should be noted.

Falling Ceiling (FMB-2)

Falling ceilings frequently have been a high hazard to life. As a building sways during an earthquake shock, a suspended ceiling may sway with its own natural period of vibration unless braced to walls or braced to structural floors with diagonal braces (usually wires). Where tee-bar system members or rolled channels terminate at a wall or other structural member, the attachment is frequently very loose and may easily slip off its support, causing the adjacent ceiling area to drop. After observing damage to suspended ceilings in recent earthquakes, earthquake resistant recommendations have been and are still being formulated to control this damage. Few existing structures are provided with ceilings designed to meet these requirements.

As a rule of thumb, the present state-of-the-art requires that suspended ceiling systems be provided with X-brace wire diagonals in addition to the usual vertical wire hangers with the spacing of these wire hangers limited to the X-bracing's ability to carry laterally 20% of the ceiling weight. The ceiling weight should include the weight of light fixtures supported laterally by the ceiling system. Where removable or demountable partitions terminate at the ceiling they must also be stayed laterally by the ceiling system and the lateral force should be added in when the adequacy of the bracing system is analyzed. Where bracing is not used and the ceiling system members are tied firmly to exterior walls or structural elements, the continuity of ceiling framing members should be investigated as well as the end connections to the walls.

Falling Light Fixtures (FMB-2)

Heavy light fixtures should generally be independently supported from the floor or roof above. Such fixtures will tend to sway and are actually pendulums. Anchorage of lighting fixtures is described in chapter 13, page 8-11, of the Tri-Service Manual [3.1]. This is reproduced here.

> Lighting Fixtures in Buildings: In addition to the requirements of the preceding paragraphs, lighting fixtures and supports will conform to the Standards for Safety UL-57 and requirements given hereinafter.
>
> a. Materials and Construction
>
> (1) Fixture supports will employ materials which are suitable for the purpose. Cast metal parts, other than those of malleable iron, and cast or rolled threads will be subject to special investigation to assure structural adequacy.
>
> (2) Loop and hook or swivel hanger assemblies for pendent fixtures shall be fitted with a restraining device to hold the stem in the support position during earthquake motions. Pendent supported fluorescent fixtures shall be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.
>
> (3) Each recessed fluorescent individual or continuous row of fixtures shall be supported by a seismic resistant suspended ceiling support system and shall be bolted thereto at each corner of the fixture; or shall be provided with fixture support wires for individual fixtures and one wire per unit of continuous row of fixtures.
>
> (4) A supporting assembly which is intended to be mounted on an outlet box will be designed to accommodate mounting features on four-inch boxes, three-inch plaster rings, and fixed studs.
>
> (5) Each surface mounted fluorescent individual or continuous row of fixtures shall be attached to a seismic resistant ceiling support system. Fixture support devices for attaching to suspended ceilings shall be a locking type scissor clamp or a full loop band which will securely attach to the ceiling support. Fixtures attached to underside of a structural slab shall be properly anchored to the slab at each corner of the fixture.
>
> (6) Each wall mounted emergency light unit shall be secured in a manner to hold the unit in place during a seismic disturbance.

D. Rating of Building Resistance to Wind Hazards (FMC Forms)

The purpose of FMC Forms is to determine the capability of buildings to withstand wind forces that can reasonably be expected to occur in the particular area involved. A probable wind velocity will be assigned to individual areas by the user. This usually will be given in terms of anticipated wind velocities at a height of 30 ft above ground level at a mean recurrence interval. Wind velocities can be varied by such factors as height above ground and the exposure which considers the character of the environment. Research on these items has given a basis for developing criteria for effective velocity pressures based on these factors. ANSI-A58.1-1972 [3.2] (Articles 6.3.3, 6.3.4, 5.3.4.1, and 6.3.4.2) describes "Effective Velocity Pressure" and how this pressure is varied by various factors. The exposure factor of course has to be generalized. The height factor can perhaps be easily determined. Section 3.4 of this chapter discusses in detail the factors affecting and the methods of obtaining wind pressures. The reader is referred to that section in addition to ANSI-A58.1 to supplement the comments made in this section.

Damage to a building is dependent on two basic considerations. One side of the equation is the effective wind force, usually in terms of pressure, positive or negative given in pounds per square foot of surface. On the other side of the equation is the resistive capacity of the structure to lateral forces and also to uplift forces on the roof created by the structure's shape.

ANSI-A58.1-1972 is currently the most accepted source of design criteria for winds other than tornadoes. For the purpose of this report, this publication will be referred to for use in the evaluation of buildings subjected to wind hazards. Subsequent editions of ANSI-A58.1 would supersede these criteria if and when adopted. The publication gives criteria, curves, charts, and formulas for the design of structures subjected to severe winds. These criteria will be used in the evaluation of possible damage to structures by the Approximate and Detailed Analytical Methods. Criteria other than 1972 ANSI may be used but should be clearly noted on the forms.

For structures to be evaluated by the Field Evaluation Method, certain simplification must be made. The basic factors which can vary the effect of wind forces on structures are:

- Exposure
- Height
- Degree of Enclosure
- Weight and Foundation Anchorage
- Shape Factor

For simplicity all but shape factors should be considered in the formulation of a Field Evaluation Method rating.

Rating of Structural Systems - Wind (FMC-1)

This type of evaluation is limited by the information that can be collected by a field team without major calculations. The necessary information on structures for the Field Evaluation Method for both wind and earthquake is to be obtained from the DC Form. The evaluation is done on Form FMC-1.

The rating system used for structural systems in resisting earthquakes can be used also for wind because the rating is a measure of a building's ability to resist lateral forces. In the case of wind, in addition to lateral pressures, there are factors which involve high suction or uplift forces on the roofs of light buildings, overhanging roofs, roof anchorage, and anchorage to foundation and internal pressure. Internal pressures are greatly affected by the degree of building enclosure. The distribution of openings in the walls and the location of openings on windward, leeward, or side walls will also be important factors in determining actual internal pressures.

The rating of the structural system is given in the form of a ratio of the design unit wind pressure to an effective capacity unit pressure.

The "Effective Unit Velocity Pressure (P_c)" is given in pounds per square foot for each of the "Corrected Structural Ratings." Obviously, without calculation, these capacity ratings will be very approximate. They are based on experience, judgment and previous calculations made on various types of buildings.

A "Corrected Structural Rating" is determined by taking the highest numerical rating of the "Foundation Anchorage" factor, "Roof Anchorage" factor, or the "Basic Structural Rating" since these factors affect the building's capacity to resist wind independently.

In buildings subjected to high velocity winds, the entire building may have net uplift forces on the connections to the foundations. This may be quite critical in buildings with little weight to resist the uplift. An approximate estimate of the building weight will be needed to determine this factor. The roof must be adequately anchored to resist uplift forces which may exceed the weight of the roof.

Calculations for enclosure factors are beyond the scope of the Field Evaluation Method. An approximation of the degree of enclosure should be obtained from the DC Form. In unenclosed buildings or partially enclosed buildings, the uplift factor on the roof may be very severe and the "Foundation" and "Roof Anchorage" factors noted on FMC-1 should be increased numerically by half a point. The major problem involved with unenclosed or partially enclosed buildings is the anchorage of roof to vertical supports and the anchorage of wall elements. Where this anchorage is questionable or cannot be confirmed by original design computations, a review by the Approximate Analytical Method should be made.

Rating of Other Life Hazards - Wind (FMC-2)

During extremely high winds, special hazards to life may be caused by such phenomena as breaking glass, wind borne objects which in effect become missiles, and/or the tearing loose of roof panels, exterior wall panels, wall cladding or ornamental exterior appendages.

Glass in exterior walls or skylights is subjected to direct wind pressure. In a direction normal to the surface this can be much greater than earthquake forces which are a function of the weight of the glass itself. Therefore, the strength of the glass, as well as its anchorage is of utmost importance in evaluating the wind hazard. In the direction parallel to the plane of the glass, the critical item is the distortion of the enclosing frame. In a flexible structure, the glass may crack up unless the attachment to the frame allows for such distortion through the use of resilient materials or a space allowance. The size of pane should be checked with respect to these provisions.

Missile damage has been recorded in many high wind occurrences. Wind has been known to pick up gravel from roofs and even relatively heavy objects. The effects of such flying objects can be severe, such as when the point of impact is a glass panel on the exterior of a building.

Roof panels are subjected to frequent high uplift pressures during winds. When not securely fastened down, individual light roof panels can be torn loose and become flying missiles. Exterior wall panels, cladding and ornamental appendages may be subjected to severe positive or negative pressures. If the attachments are not adequate to resist the forces resulting from these pressures, such elements may also become flying missiles. Where such elements occur adjacent to a public way, they can be especially hazardous.

E. Rating of Building Resistance to Tornado Hazards (FMD Form)

Tornadoes, although having some statistical influence on the climatology records on which design winds speeds are based, pose special difficulties because of their short-time duration, small radial extent, and wide-range of maximum forces. The effective radial extent of a tornado may be less than a few hundred feet and is usually less than a mile. Tangential wind speeds of 200 miles per hour are probable. The pressure drop may be as much as 2 to 2.5 p.s.i. [3.3]. In the immediate path of a tornado, these wind pressures, both vertical and tangential can be devastating to certain types of buildings. Suction forces in the order of 400 lbs per square foot have been observed [3.3]. Obviously such uplift forces can pick up very heavy objects and pull a roof off a building.

Comments on the Use of FMD Rating Form

Damage from tornadoes has been most severe to small, light buildings; although, tall, flexible, and heavier buildings have sustained some severe structural damage. The most extensive damage to buildings has been to roofs and exterior cladding, including glass. This includes damage from wind blown debris. For the Field Evaluation Method, with the present state-of-the-art, a bad risk rating must be given to small, light buildings. A medium risk rating to small, heavy buildings, and to large, multi-story buildings that could be rated high in wind resistance or earthquake resistance. A good rating can only be given to heavy vault-like structures or structures known to have been designed for tornadoes under the criteria given by the Atomic Energy Commission. Very few buildings have actually been designed to resist tornadoes. Since 1967 the Atomic Energy Commission (AEC) has required designers of nuclear reactor facilities to carefully consider the effects of tornadoes on such facilities and have developed design criteria for this [3.4]. These criteria are very severe and would impose large additional costs on an average commercial building.

For the Field Evaluation Method considerable judgment must be exercised. For the building as a whole, the evaluation for wind is made on Form FMC. Tornado velocities can be much higher than other wind velocities but the capability of a building to resist high wind or hurricane velocities gives us some comparison. The "P_c" as determined for wind is used as a basis for tornado evaluation. The highest rating given based on the P_c comparison is "Fair." However, there are certain vault-like buildings which are inherently highly resistant to tornadoes. For the purpose of this method a vault-type building is defined as a building with a length-width ratio and a height-width ratio of two or less which has exterior walls of reinforced concrete or reinforced masonry and a reinforced poured-in-place concrete roof with not over 15% of the area of the walls or roof having openings.

The hazards from flying debris originating outside the facility can only be roughly evaluated. There are two sources of damage: one is from debris originating outside the building; the other is from elements of the building itself, such as broken glass, loose cladding, and appendages.

The path of a tornado cannot be predicted. The facility in question may be protected by surrounding structures but these surrounding structures themselves may have cladding or appendages which may be potential wind-blow missiles if a tornado moves through the area. In a lightly built-up area, the proximity of storage yards for such things as lumber, masonry units, and even automobiles may create a hazard for buildings. The DC Form includes a space for comment on the availability of loose material in the nearby area that could be airborne in a tornado and for obvious looseness of cladding or appendages on nearby buildings. Ratings for this type of hazard for the Field Evaluation Method can be given as large hazards or small hazards only. The data collectors will not be expected to survey all structures or all areas within, say, a quarter mile of the facilities.

The hazards from broken glass, loose appendages, or cladding originating in the building itself are similar to those discussed in wind evaluation, but the forces produced by tornadoes can be much greater. The criteria set up for anchorage of appendages and cladding will not protect from tornadoes. Neither will the criteria for wind set up for glass, glazing, and window frame anchorage. Localized pressures of over 250 p.s.f. positive or negative may occur in tornadoes and this will break most glass or blow it out or in.

The FMD Form has a space for noting the availability of basements for emergency storm shelters. Since tornadoes move laterally up to, say, 60 miles per hour, the duration of use for such a shelter is short. The form merely notes the presence or absence of such a basement and the capacity based on 15 square feet per person. Basements of buildings having heavy concrete ground floor slabs are potentially good emergency storm shelters for tornadoes. This is true even if the superstructure is heavily damaged. The DC Form has spaces for noting this information. The basement should be dry and not contain hazardous equipment such as those in a transformer vault or highly flamable materials in large quantities.

F. Resume of Ratings - Structural Systems - Capacity Ratios (FME Form)

Form FME takes data from Forms FMA-1, FMA-2 and FMC-1 to determine "Capacity Ratios." The "General Rating" for earthquake is weighted with "Sub-Rating (SRI)" and "Sub-Rating (SR2)" to arrive at the "Basic Structural Rating."

Reference is made on Form FME to the Modified Mercalli Scale. This scale is a measure of ground motion intensity at a particular location. Other scales have been used or are being proposed. However, the Modified Mercalli Scale is the most commonly used at the present time. Table 2.1 presents a summary of the Modified Mercalli Intensity Scale (MMI). On Form FME the relation of Intensity Level Factors to Modified Mercalli Scale is based on judgment and interpretation of the Modified Mercalli Scale. The "Basic Structrual Rating" is compared to the "Intensity Level Factor" to obtain the "Capacity Ratio" for earthquakes. The "Capacity Ratio" for wind is taken directly from FMC-1. For capacity ratios greater than 1.5 on important buildings, an evaluation using either the Approximate or Detailed Analytical Method should be made.

Table 2.1 should be used to select MMI intensity. The reader may find it helpful for his particular region of the United States to relate UBC Seismic Risk Zone ratings with general MMI intensity levels. Figure 2.3 and table 3.3 should assist in such a characterization.

Table 3.3 UBC SEISMIC RISK ZONES AND MMI INTENSITIES

UBC Seismic Risk Zone (see Figure 2.3)	Modified Mercalli Intensity (MMI)
0	below V, no damage
1	V and VI, minor damage
2	VII, moderate damage
3	VIII or higher, major damage

3.3 APPROXIMATE ANALYTICAL EVALUATION METHOD

A. Introduction

The approximate analytical procedures are developed in this section. The capability of an existing building to resist natural hazards is evaluated by determining stress ratios of critical structural and nonstructural elements. These stress ratios are the ratios of the stresses produced by the loading to limiting stresses of the critical building elements. This method can be used only when plans and personnel capable of making structural calculations are available. If original calculations are available, the method becomes a checking procedure. If not, new calculations must be made. The procedures for calculations are described later in this section. This method gives more accurate results than the Field Evaluation Method. It can usually be done by hand calculation, although computer programs may be used if available. The Approximate Analytical Evaluation Method in general, does not include the use of a dynamic analysis except in special cases.

B. Rating of Building for Resistance to Earthquake Hazards

Information Necessary for the Method

The establishment of the seismicity for any given site will be selected by the user. This seismicity may be determined in several different ways. If they can be obtained, the recurrence rate and probability of occurrence at the site for earthquakes originating along various faults at varying distances from the site should be taken into consideration to establish the appropriate level of seismic motions. The seismicity factor may be simply that specified on macrozoned maps, it may be determined from an assumed site earthquake intensity, or by one of several methods as described later.

It is assumed that detailed construction plans are available for review and that these plans have been verified roughly by a field team and that the Data Collection Form, see Appendix A, has been completed. This field verification will show whether additions or major changes have been made since the plans were produced. If changes have been made, plans showing these changes should be obtained to show the "as-built" conditions.

If possible, the original structural calculations should be obtained. In areas where seismic design is required by governmental authorities, such calculations will be of valuable assistance in the evaluation of the earthquake hazard. In other areas where there are no seismic requirements, calculations may cover only vertical load design,or possibly vertical load plus wind. Even these will aid in the evaluation.

A soils report may be available giving recommended bearing pressures, or pile capacities. If such a report is not available,the adequacy of the foundation design may be roughly estimated by the test of time. Thus, if the building shows no evidence of settlement damage over a period of several years and has been subjected to probable weather hazards, the foundation design criteria originally used was probably adequate, at least for vertical loads. If there is evidence of settlement, which usually shows up in diagonal cracks in walls or partitions, the foundation design criteria will be questionable and additional data should be obtained. If no foundation, or soil report is available, information possibly may be obtained from soils investigation of adjoining properties, or from the local building officials.

Criteria for the Method

The criteria used for the Approximate Analytical Evaluation Method will be an appropriate building code. Any building code containing compatible load and resistance functions may be used. However, the explicit code used herein will be the 1973 Edition of the Uniform Building Code [2.5]. Specifically, Chapter 23 of the code relating to earthquake design and Chapters 24, 25, 26, 27 and 28 giving allowable working stresses and design criteria for masonry, timber, concrete, steel and iron, and aluminum respectively.

Limitations of the Method

A more complex type of evaluation called Detailed Analytical Evaluation Method is given in section 3.4. In that method the seismicity of the particular area will be determined using a predetermined base rock motion modified by the dynamic amplification of the soil. The surface ground motion will be found in terms of maximum velocity, acceleration, and displacement. From this, elastic spectral response curves for single degree of freedom masses are derived and plotted. Modified spectra are developed for the effects of variations in damping and inelastic behavior. Thus, if the dynamic characteristics of the structure are known (including the damping) the acceleration, velocity and displacement of each mode can be determined.

For multi-degree of freedom systems, the participation of each mode is determined and these are superimposed to arrive at the building response. In the Approximate Analytical Evaluation Method, these types of dynamic analyses, in general, will not be used. However, if the site data are available, say from a complete analysis of an adjoining building, a procedure is provided in the Approximate Analytical Evaluation Method to make use of this information for site seismicity. Also, the mode shapes of the building may be needed if the building is highly irregular in the mass to stiffness ratios of adjoining stories as described later.

Base shears as computed using 1973 UBC [2.5] specified values in the various zones are less than would be determined by the more explicit dynamic methods but is compensated for by the use of working stresses in material resistances. Dynamic response of a structure has been simulated in the 1973 UBC by the use of a triangular distribution of base shears and by varying these base shears with the natural period of the building. Experience has shown that most buildings designed by UBC criteria have come through earthquakes satisfactorily. The philosophy in seismic design is expressed by the Structural Engineers Association of California (SEAOC) in their recommendations that structures designed in conformance with the provisions and principles set forth in the SEAOC Code [3.6] (incorporated in the UBC seismic design criteria) should be able to:

- Resist minor earthquakes without damage.
- Resist moderate earthquakes without structural damage but with some non structural damage.
- Resist major earthquakes of the intensity or severity of the strongest experienced in California, without collapse, but with some structural damage as well as non structural damage.

The 1973 UBC criteria does not include an explicit parameter for the influence of the supporting soils in the base shear formula. In the formula $C = \frac{.05}{\sqrt{T}}$,((14-2) on page 128 of 1973 UBC), arbitrary methods of computing T are permitted to be used or "properly substantiated technical data may be submitted." In Formula (14-1) on the same page of 1973 UBC, V = ZKCW, the selection of values for K recognize variations in response of different types of buildings and lateral force resistant systems. These are judgment factors reflecting experience and evaluation of the performance of structures in major and moderate earthquakes.

The distribution of forces throughout the height of the structure is primarily a triangular distribution of forces which approaches the dynamic response of uniform multi-degree of freedom systems. Deviations from this distribution for very flexible type buildings are recognized by the inclusion of a portion of the base shear as a special force applied to the top level designated F_t.

There are computer programs for checking moment-resistant frames for lateral forces. If it is not desired to use such a computer check there are several hand calculation methods frequently used. The Structural Engineering Handbook by Gaylord and Gaylord, 1968 Edition, [3.7] describes such methods as the portal method and the cantilever method in which the relative stiffness of columns and girders is disregarded. The more accurate moment distribution method is also mentioned. In this book reference is also made to the Spurr, Goldberg, and Grinter methods which add certain refinements. Another reference is the Theory of Modern Steel Structures, Volume II, Chapter 6, by Grinter, [3.8] which gives several methods for analyzing rigid frames subjected to lateral forces. The method most consistent with the degree of accuracy required for the facility being investigated should be used.

The earthquake effects on a structure that are evaluated using the Approximate Analytical Evaluation Method procedures are those resulting from shaking. Not evaluated are the earthquake effects which produce foundation settlements or failures, ground lurching or liquefaction, surface trace of earth faulting, failure of the slope beneath the structure, tsunamis, seiches, or inundation resulting from dam or reservoir failure.

Commentary on Setbacks and Dynamic Irregularities

Forces on irregular structures are covered in 2314(d)1 on page 128 of 1973 UBC in Exception 2 to Equation 14-2 as follows:

> "Buildings or structures which have highly irregular shapes, large differences in lateral resistance or stiffness between different stories or other unusual structural features affecting seismic response shall be designed for forces which their dynamic properties induce.

Setbacks are covered in 2314(i), page 130 of the same code and states:

> "Buildings having setbacks wherein the plan dimension of the tower in each direction is at least 75 percent of the corresponding plan dimension of the lower part may be considered as a uniform building without setbacks for the purpose of determining seismic forces."

> "For other conditions of setbacks the tower shall be designed as a separate building using the larger of the seismic coefficients at the base of the tower determined by considering the tower as either a separate building for its own height or as part of the overall structure. The resulting total shear from the tower shall be applied at the top of the lower part of the building which shall be otherwise considered separately for its own height.
>
> > EXCEPTION: Nothing in this subsection shall be deemed to prohibit the submission of properly substantiated technical data for establishing the lateral design forces by a dynamic analysis."

For the purpose of this evaluation, at least the first three mode shapes and periods for irregular buildings over two stories are required to be determined. The first step is to determine the mass and stiffness associated with each story. Next, the periods and mode shapes are determined using standard equations and procedures. This step can be very difficult and time-consuming to perform by the hand methods. Computer solutions, see section 3.4E or [3.9], are readily available and should be used. Modal participation factors can be determined after the mode shapes are known. These frequently are part of the computer program, but can be easily done by hand. Using this information and the prescribed base shear from the code, the shear distribution of the lateral forces can be determined.

Commentary on Diaphragms

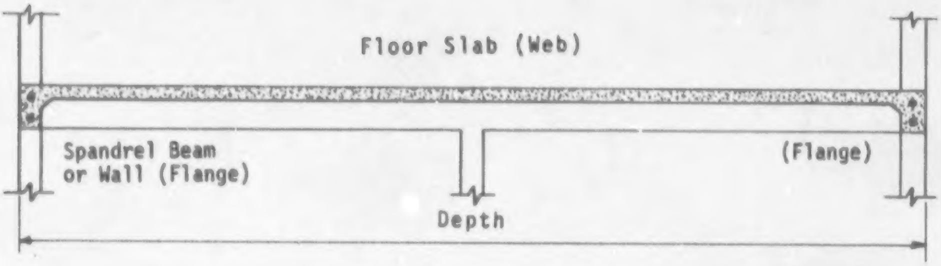
Floor and roof systems can function as diaphragms to distribute horizontal forces to vertical resisting elements. These functional characteristics are discussed in the Tri-Service Manual "Seismic Design for Buildings" [3.1, section 2]. Portions of this are presented here to illustrate items to be considered in analysis of diaphragms.

"2-04. DIAPHRAGMS: Horizontal forces at any floor or roof level may be distributed to the vertical resisting elements by using the strength and rigidity of the floor or roof deck as a diaphragm. A diaphragm may be considered analogous to a plate girder laid in a horizontal (or inclined in the case of a roof) plane where the floor or roof deck performs the function of the plate girder web, the joints or beams function as web stiffners, and the peripheral beams or integral reinforcement function as flanges. A diaphragm may be constructed of materials such as concrete, wood, or metal in various forms. Combinations of materials are possible. Working stresses for such materials as cast-in-place reinforced concrete and structural steel are well-known and present no problem to the designer once the loading and reaction system is known. Other materials frequently used to support vertical loads in floors or roofs have well established vertical load characteristics but have required tests to demonstrate their ability to resist lateral forces. Various types of wood sheathing and steel decks fall in this category. Where a diaphragm is made up of units such a plywood, precast concrete floor units or steel deck units, its characteristics are, to a large degree, dependent upon the attachments of one unit to another and to the supporting members (see figure 3.6).

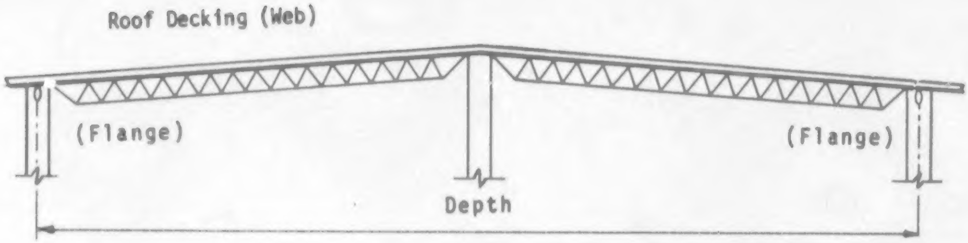
a. Seismic Loadings. Floors and roofs used as diaphragms will be designed for a lateral force of $F_p = ZC_pW_p$ acting in any direction unless a greater force is required by the basic seismic formula V = ZKCW (see figure 3.7).

b. Distribution of Seismic Forces. The total shear (F_p or V) at any level will be distributed to the various vertical elements of the lateral force resisting system (shear walls or moment-resisting frames) in proportion to their rigidities considering the rigidity of the diaphragm. The effect of diaphragm stiffness on the distribution of lateral forces is discussed and schematically illustrated in figure 3.4. For this purpose, diaphragms are classified into four groups of relative flexibilities. These are rigid, semi-rigid, semi-flexible and flexible diaphragms. No diaphragm is actually infinitely rigid and no diaphragm capable of carrying a load is infinitely flexible.

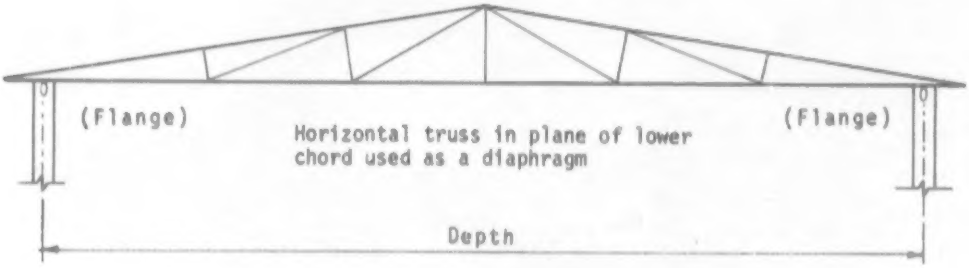
(1). A rigid diaphragm is assumed to distribute horizontal forces to the vertical resisting elements in proportion to their relative rigidities. In other words, under symmetrical loading a rigid diaphragm will cause each vertical element to deflect an equal amount with the result that a vertical element with a high relative rigidity will resist a greater proportion of the lateral force than an element with a lower rigidity factor.


Floor Slab (Web)
Spandrel Beam
or Wall (Flange)
(Flange)
Depth

FLOOR SLAB DIAPHRAGM

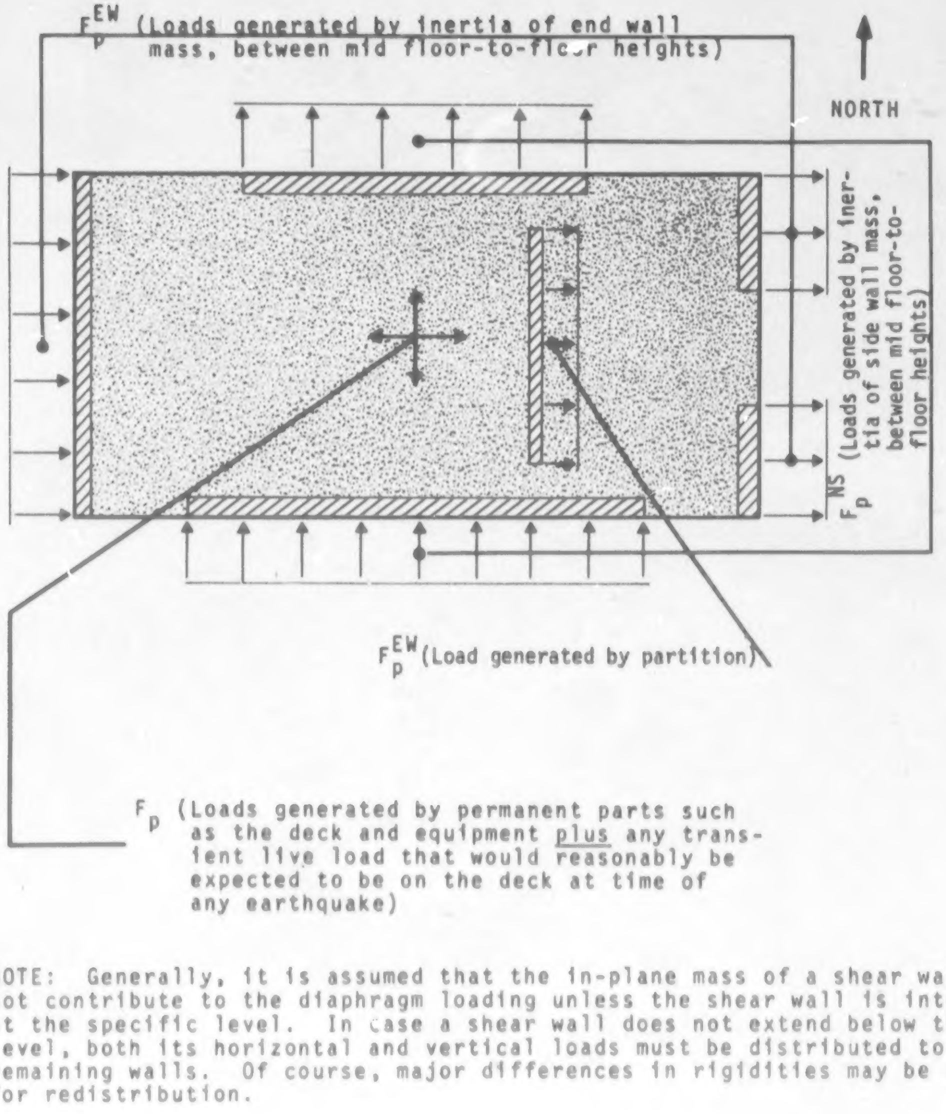

Roof Decking (Web)
(Flange)
(Flange)
Depth

ROOF DECK DIAPHRAGM


(Flange)
(Flange)
Horizontal truss in plane of lower
chord used as a diaphragm
Depth

TRUSS DIAPHRAGM

Figure 3.6 Structural Diaphragms


F_p^{EW} (Loads generated by inertia of end wall mass, between mid floor-to-floor heights)
NORTH
F_p^{NS} (Loads generated by inertia of side wall mass, between mid floor-to-floor heights)
F_p^{EW} (Load generated by partition)
F_p (Loads generated by permanent parts such as the deck and equipment plus any transient live load that would reasonably be expected to be on the deck at time of any earthquake)

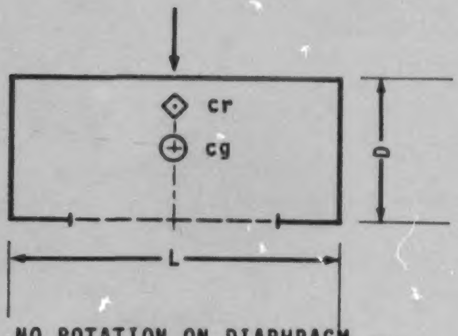
*NOTE: Generally, it is assumed that the in-plane mass of a shear wall does not contribute to the diaphragm loading unless the shear wall is interrupted at the specific level. In case a shear wall does not extend below the floor level, both its horizontal and vertical loads must be distributed to the remaining walls. Of course, major differences in rigidities may be cause for redistribution.

Figure 3.7 Diaphragm Loading

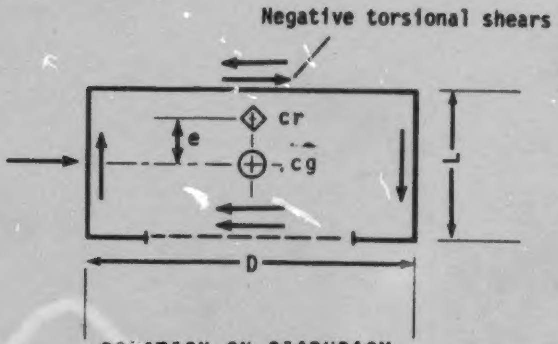
(2). A flexible diaphragm is analogous to a shear deflecting continuous beam or series of beams spanning between supports. The supports are considered non-yielding as the relative stiffness of the vertical resisting elements compared to that of the diaphragm is great. Thus a flexible diaphragm will be considered to distribute the lateral forces to the vertical resisting elements on a tributary load basis. A flexible diaphragm will not be considered capable of distributing torsional stresses resulting from concrete or masonry masses.

(3). Semi-rigid and semi-flexible diaphragms are those which have significant deflection under load but which also have sufficient stiffness to distribute a portion of their load to vertical elements in proportion to the rigidities of the vertical resisting elements. The action is analogous to a continuous concrete beam system of appreciable stiffness on yielding supports. The support reactions are dependent on the vertical elements. A rigorous analysis is sometimes very time-consuming and frequently unjustified by the results; at best, the results are no better than the assumptions that must be made. In such cases a design based on reasonable limits may be used; however, the calculations must reasonably bracket the likely range of reactions and deflections.

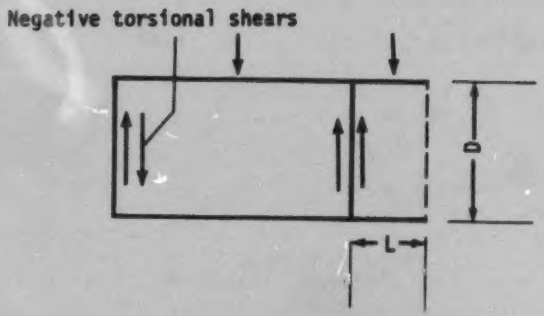
(4). Torsional moment is generated whenever the center of gravity (cg) of the lateral forces fails to coincide with the center of rigidity (cr) of the vertical resisting elements, providing the diaphragm is sufficiently rigid to transfer torsion. The magnitude of the torsional moment that is required to be distributed to the vertical resisting elements by a diaphragm is determined by the sum of the moments created by the physical eccentricity of the translational forces at the level of the diaphragm from the center of rigidity of the resisting elements ($M_T = F_p e$, where e = distance between cg and cr) and the "accidental" torsion of 5%. The "accidental" torsion is an arbitrary code requirement equivalent to the story shear action with an eccentricity of not less than 5% of the maximum building dimension at that level. The torsional distribution by the more rigid diaphragms to the resisting elements will be assumed to be in proportion to the stiffness of the elements and its distance from the center of rigidity. Negative torsional shears will be neglected. The more flexible diaphragms will not distribute torsional shears. Cantilever diaphragms on the other hand will distribute translational forces to vertical resisting elements, even if the diaphragm is flexible. In this case, the diaphragm and its chord act as a flexural beam on supports (vertical resisting elements) whose resistance is in the same direction as the forces, see figure 3.8.



NO ROTATION ON DIAPHRAGM


Negative torsional shears
cr
e
cg
L
D

ROTATION ON DIAPHRAGM


Negative torsional shears
D
L

CANTILEVER DIAPHRAGM

Figure 3.8 Torsional Force Considerations

c. Diaphragm Deflections. A diaphragm should be capable of providing such stiffness and strength so that walls and other vertical elements laterally supported by the diaphragm can safely sustain the stresses induced by the response to seismic motion. The total computed deflection (Δ_d) of the diaphragms under the prescribed static seismic forces consists of the sum of two components. The first component is the flexural deflection (Δ_f) of the diaphragm which is determined in the same manner as the deflection of beams. The assumption that flexural stresses on the diaphragm web are neglected will be used except for reinforced concrete slabs. For such slabs the proportional flexural stresses also may be assumed to be carried by the web. The second component is the web deflection (Δ_w) of the diaphragm. The specific nature of the web deflection will vary depending on the type of diaphragm. The deflection of the diaphragm under the prescribed static forces will be used as the criteria for the adequacy of the stiffness of a diaphragm. The limitation on deflection is the allowable amount prescribed for the relative deflection (drift) of the walls between the level of the diaphragm and the floor below. In design a limitation imposed on diaphragms supporting flexible walls is a maximum span-to-depth ratio, see table 3.4.

d. Flexibility Limitations. The determination and limitations of the deflections of a diaphragm is a design function. The deflections of some diaphragms can be computed with reasonable accuracy. However, other diaphragms have characteristic and fabrication variables making an accurate solution of deflection characteristics meaningless. Thus the methods of determination of the deflection characteristics for diaphragms of all materials given herein will be used to keep the range of diaphragm deflections within reasonable limits. In order to provide a means of properly classifying and identifying the stiffness of a diaphragm web, the factor "F" will be introduced.

$$F = \frac{\Delta_w \times 10^6}{q_{ave} L_1} \qquad (3.3.1)$$

where:

L_1 = Distance in ft. between vertical resisting element (such as shear wall) and the point to which the deflection is to be determined.

q_{ave} = Average shear in diaphragm in pounds per ft. over length L_1.

Δ_w = Web component of Δ_d.

Table 3.4 FLEXIBILITY LIMITATION ON DIAPHRAGMS

FLEXIBILITY CATEGORY	F (see eq. 3.3.1)	MAXIMUM SPAN (feet)	SPAN/DEPTH LIMITATIONS			
			No Torsion In Diaphragm[3]		Torsion in Diaphragm[2]	
			Brittle Walls[1]	Flexible Walls	Brittle Walls[1]	Flexible Walls
Flexible	Over 70	100	2:1	3:1	Not used	2:1
Semi-Flex.	10-- 70	200	2 1/2:1	4:1	Not used	2 1/2:1
Semi-Rigid	1-- 10	300	3:1	5:1	2:1	3:1
Rigid	Less than 1	400	Deflection Reqm't Only	No Limitation	Deflection Reqm't Only	3 1/2:1

Notes:

1. Walls in concrete and unit-masonry are classified as brittle; in all cases, check allowable drift before selecting type of diaphragm.

2. When applying these limitations to cantilever diaphragm , the span/depth ratio shall be limited to one-half that shown.

3. No torsion in diaphragm other than the 5% "accidental" torsion required by SEAOC Code.

Conversely, the web deflection will be determined by the equation

$$\Delta_w = \frac{q_{ave}L_1F}{10^6} \qquad (3.3.2)$$

Using the factor F, the flexibility categories of diaphragm webs have designated values as prescribed in table 3.4. The span-depth limitations do not directly reflect deflections. But, if the diaphragm is designed within the proper ratio, the deflection requirements will be considered to be met unless an unusual building layout is used wherein deflection criteria would become critical.

Floor and roof diaphragms may be of poured-in-place concrete, wood with diagonal or plywood sheathing, metal decks with or without structural concrete topping, precast concrete units a poured-in-place topping and, in the case of roofs, a cast-in-place gypsum deck. Horizontal steel bracing systems are sometimes used. These are commented on in the next few paragraphs. Design examples of these can be found in the Tri-Service Manual [3.1].

Poured-in-place concrete floors or roofs can be analyzed in accordance with Chapter 26 of UBC. Flexural stresses in the diaphragm resisted by chord elements should be analyzed. For instance, in a rectangular building where the vertical resisting elements are in the exterior walls, there may be concrete beams acting as supports for vertical loads, plus functioning concurrently as a horizontal diaphragm chord. The reinforcing steel stress should be checked for the combination of these two functions. Reinforcement around openings in concrete diaphragms should be checked for adequacy to carry diaphragm shears and bending moments. Minor holes frequently can be ignored in their effect on diaphragm capacity.

Where a stairwell is adjacent to a shear wall, the interface between diaphragm slab and shear wall is reduced in length and should be checked for shear. The transfer of forces from the concrete diaphragm to interior shear walls or vertical bracing elements walls should be checked. Special tie-struts developed into such shear walls and diaphragms are sometimes required for this transfer.

Where a vertical resisting element occurs in an upper story but is not present in the same location in the story below, the diaphragm must be able to transfer the horizontal force from the upper element to a lower element in another plan location.

For wood diaphragms the allowable stresses and shape limitations of various types are given in paragraph 5-07 of the Tri-Service Manual and in Section 2514 of the 1973 UBC.

There are many types of metal deck diaphragms. There are different configurations, gauges and fastening patterns. Allowable stresses in metal decks acting as diaphragms have generally been determined by tests and special approvals have been given for most of the commonly used decks by building code authorities based on these tests. In most cases the deck manufacturer has published the diaphragm shears approved by such agencies. The governing building agency for the area involved may be contacted for such values or special approvals [3.10]. For example, the International Conference of Building Officials (ICBO) will furnish these on request [3.10]. Formulas for computing metal deck diaphragm shear values may be found in paragraph 5-06 of the Tri-Service Manual. Metal decks with concrete topping slabs are also covered therein.

Precast concrete floor diaphragms units such as concrete plank, concrete tees or double tees are frequently used as floor construction. The diaphragm resistance of such units depends on the connections between units and their supporting elements and the connections to the diaphragm strut and tie elements, where no structural topping slab is used. Some tests have been made on such assemblies with considerable variations in attachment technique. These can be verified with the fabricator and usually confirmed with the governing code agency in the area involved. (ICBO will do this on request.) [3.10] Where a structural cast-in-place concrete topping is used, such concrete topping may be considered as a diaphragm slab provided it is reinforced with steel qualifying at least as temperature reinforcement.

Shear values for cast-in-place gypsum diaphragms are given in Paragraph 5-05 of the Tri-Service Manual or in the UBC Standards [2.5]. Typical details of this type of construction are also shown in the Tri-Service Manual on Plate 5-5-1.

Steel horizontal bracing systems may be analyzed as a truss. It may be continuous over several supports. Care should be taken that horizontal forces are delivered to vertical resisting elements at truss bracing panel points.

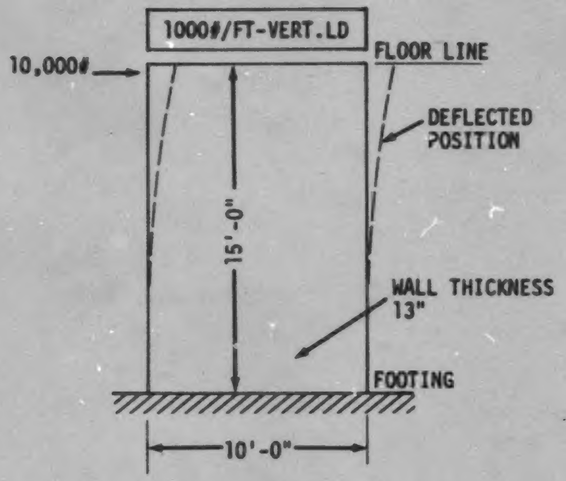
Commentary on Masonry or Concrete Walls

In computing the relative stiffness for analyzing the distribution of shears to vertical resisting elements, masonry or concrete walls (whether infill walls, curtain walls, or bearing walls) must not be ignored. Some buildings have been designed without considering masonry or concrete filler walls, assuming all lateral resistance to be supplied by the structural frame. This will not happen until the filler walls are severely damaged. All masonry or concrete walls should be checked to assure stresses will not exceed the allowable design stress, see figure 3.9. Where such walls are not isolated but are bounded by elements of the structural frame, they must deflect with the structural frame. In so doing, they assume a portion of the total resistance to lateral forces. This portion may be a relatively high percentage depending on the size and location of such walls. The difference between the lateral force resisting behavior of a structural frame and the combination of a structural frame and infill wall is illustrated in figure 3.10. Test results [3.62] indicate the drastic difference between the behavior of frames without filler walls and those with filler walls. Frames with filler walls were considerably stronger and stiffer than frames without walls. They were also much less ductile. The tests by Fiorato et. al.[3.62] also describe the influence of frame reinforcement, size, shape and location of wall openings, etc. on the behavior of frames with filler walls. Thus, when the walls are not considered in the design, the entire distribution of resistance to lateral forces may be different than that assumed.

Methods for computing the deflections of concrete and masonry walls, including a design aid chart, are shown in Section 6 of the Tri-Service Manual, a portion of which follows for ease of reference [3.1].

SAMPLE COMPUTATION - UNREINFORCED BRICK WALLS

ASSUME SOLID BRICK MASONRY - 4500 PSI
TYPE M OR S MORTAR
INSPECTED
ASSUME ALLOWABLE SHEAR OR TENSION IS 20 PSI


1000#/FT-VERT.LD
10,000#
FLOOR LINE
DEFLECTED POSITION
15'-0"
WALL THICKNESS 13"
FOOTING
10'-0"

HORIZONTAL LOAD IN PLANE OF WALL

CHECK UNIT SHEAR

$\frac{10000}{10 \times 12 \times 13} = 6.5$ PSI

CHECK OVERTURNING

$M = 10000 \times 15 = 150000'\#$

$S = \frac{13 \times 120^2}{6} = 31.200$

$M = \frac{150000 \times 12}{31,200} = 57.5$ PSI

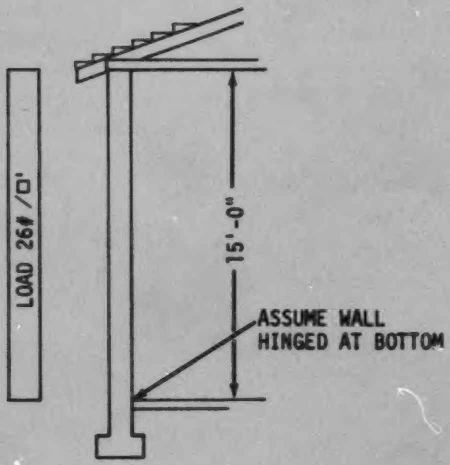
VERTICAL LOAD = 1000# COMPRESSION
$+ 15 \times 130 = \underline{1950}$
2950T PER LIN FT.
$= \frac{2950}{156} = 18.8$ PSI

MAXIMUM COMPRESSION =

$$\begin{array}{r} 57.5 \\ +18.8 \\ \hline 76.3 \end{array}$$ PSI (COMPLIES)

MAXIMUM TENSION =

$$\begin{array}{r} 57.5 \\ -18.8 \\ \hline 38.7 \end{array}$$ PSI (DOESN'T COMPLY)


LOAD 26#/□'
15'-0"
ASSUME WALL HINGED AT BOTTOM

HORIZONTAL LOAD NORMAL TO WALL

$M = \frac{26 \times 15^2}{8} = 730'\#/\text{LIN. FT.}$

S PER LIN. FT. $= \frac{12 \times 13^2}{6} = 338$

$\frac{M}{S} = \frac{730 \times 12}{338} = 26$ PSI

VERT. LD $= \frac{1000}{156} = \underline{-\ 6.4}$ PSI
19.6 PSI NET TENSION
(COMPLIES)

Figure 3.9 Sample Computation - Unreinforced Brick Walls

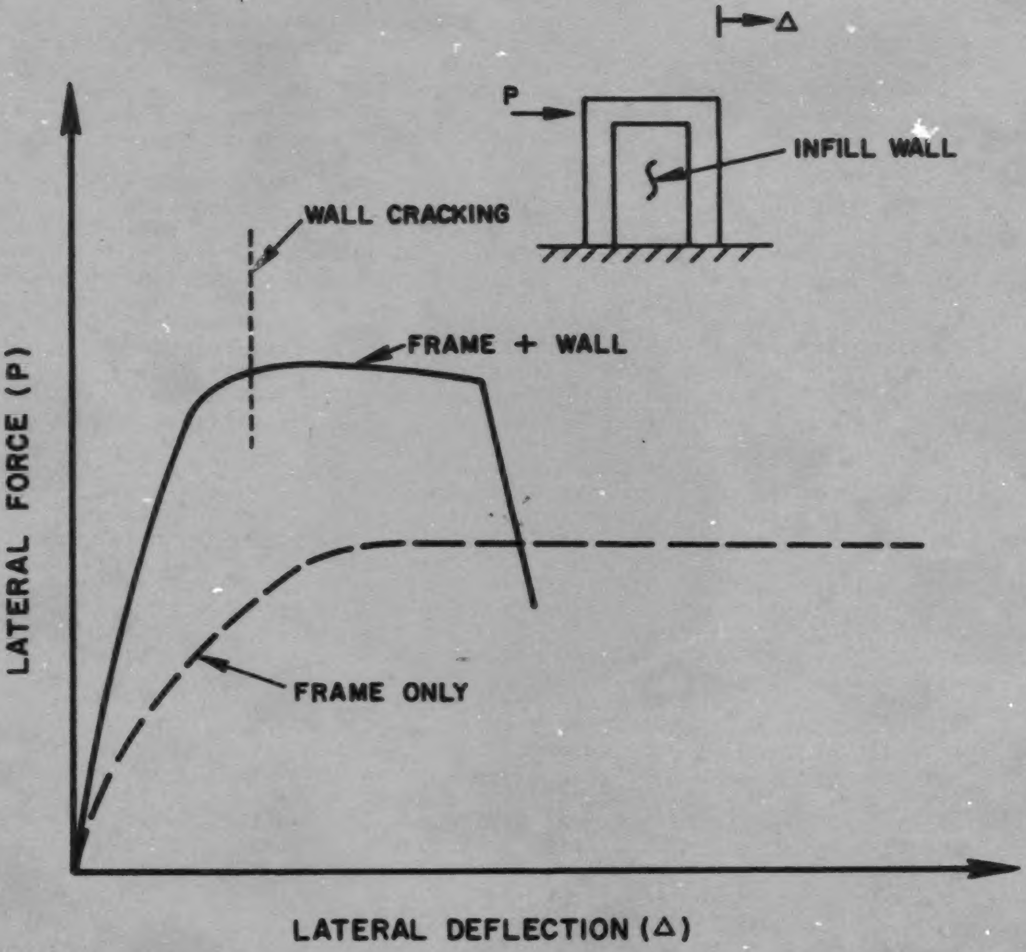


Figure 3.10 General Infill Wall-Frame Force Deflection Characteristics

CONCRETE AND MASONRY SHEAR WALLS:

a. Wall Deflections. The deflection of a concrete shear wall can be determined from the sum of the shear and moment deflections. In the case of a solid wall with no openings the computations of deflection is quite simple. However, where the shear wall has openings in it, as for doors and windows, the computations for deflection and rigidity are much more complex. An exact analysis considering angular rotation of elements, rib shortening, etc., is very time consuming. For this reason, several short-cut approximate methods involving more or less valid assumptions have been developed. These do not always give consistent or satisfactory results.

b. Shear Distribution. Where several independent shear walls are reacting forces from a rigid diaphragm in any one-story structure, the relative rigidity of the various walls must be determined. This is necessary so that a logical and consistent distribution of story shears to each wall can be made. The total height of wall from diaphragm level above to diaphragm or foundation level below frequently must be considered. Exact determination of stiffness is very difficult and not necessary. Approximate methods in which the deflections of portions of walls are combined usually are adequate.

c. Deflection Charts. Figure 3.11 shows deflection charts for concrete or masonry shear walls and piers. Curves 1 and 2 are for shear deflection only. Curve 1 is for shear deflection of a corner pier or pier with flanges and Curve 2 for a rectangular pier. Curves 3 and 4 are for fixed-ended corner and rectangular piers. Curves 5 and 6 are for cantilever corner and rectangular piers. The corner pier curves are for the special case where the I of the corner pier is 1.5 times the I of a rectangular pier. For other I values the bending portion of the deflection would be proportional. The deflection shown on the charts are for a horizontal load of P of 1,000,000 pounds. The deflections shown on the charts are reasonably accurate. The formulas written on the curves can be used to check the results. However, the charts will give no better results than the assumptions made in the shear wall analysis. For instance, the point of contraflexure of a vertical pier may not be in the center of the pier height. In some cases the point of contraflexure may be selected by judgment and an interpolation made between the cantilever and fixed conditions."

The rigidity is the inverse of deflection. Figure 3.11 also provides an approximate method for checking possible damage to infill walls. Assume that the story drift has been computed. Then enter the chart and find the load which would produce this drift in the type and shape of wall being checked. If this load would produce stresses in the wall in excess of twice the allowable working stresses, then the wall should be considered to be critically stressed.

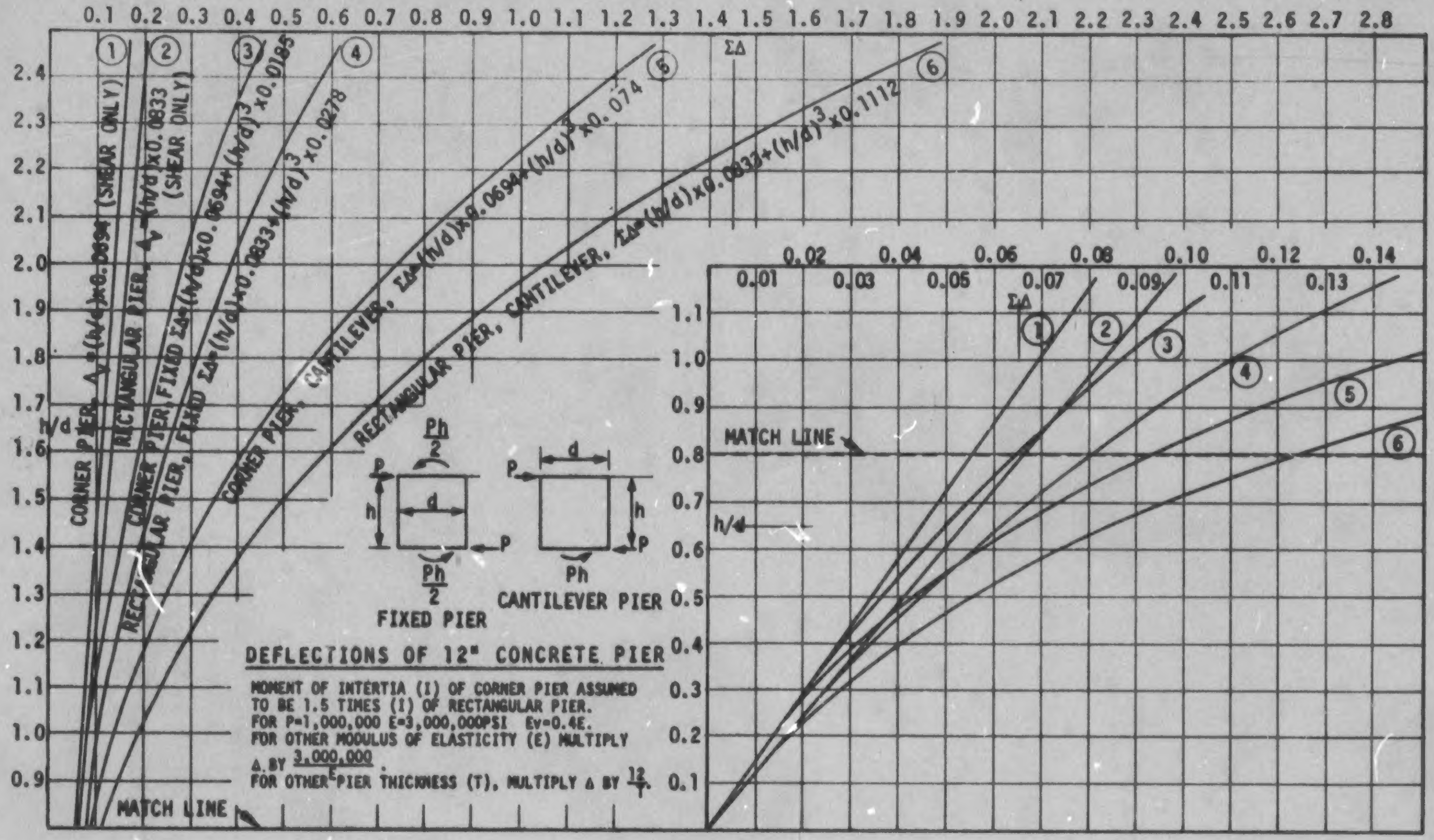


Figure 3.11 Design Curve for Masonry and Concrete Shear Walls

Effect of Damaged Elements on Evaluation

If the Data Collection Form indicates damage to a particular element of the lateral force resisting system, it should be reviewed in the field and the degree of damage assessed. The percentage of its rigidity and its capacity to resist forces should be estimated and these modified values used in the calculations.

Determination of Critical Elements

Any important earthquake resisting element having the highest unit stress as related to allowable design stresses is a critical element to be considered in the evaluation of the structural system. The term "important" element means an element which, if it failed, would seriously reduce the capacity of the structure as a whole to resist lateral forces. Some members would not be critical when deformed beyond their yield level deformations. In other members, yielding may cause an important redistribution of loads. With a multiplicity of well-distributed similar elements, the redistribution of loads would add only a small percentage of stress to adjoining or parallel elements. In a shear wall building, for instance, if a pier in a wall is highly overstressed and its force redistributed to the remaining piers without overstressing them, then the pier in question would not be a critical element. For another example, assume a large multi-story structure supported on only four columns. The failure of one of these columns could cause collapse and, in such cases, the evaluation of such columns and top and bottom connections should be viewed with special conservatism.

In most buildings the critical elements will be the vertical resisting elements (shear walls or moment resistant frames) and the horizontal resisting elements (diaphragms). This is for earthquake forces acting in the plane of the elements. Earthquake forces normal to a wall are a function of the weight of the wall itself. Where a wall has a long span between floor diaphragms or vertical frame elements it might be a critical element if its failure would produce collapse of the building as a whole from vertical loads or in plane lateral forces. Good engineering judgment in selection of critical elements may save considerable checking time. If original calculations are available, stress ratios taken from these calculations are useful in determining the most critical elements even though the original design criteria may be different from the criteria for which it is being checked.

Determination of Critical Stress Ratios

The highest ratio of stress resulting from the required seismic forces (f_e) to the allowable material design stress (f_a) (including 1/3 increase where permitted but deducting capacity required by gravity loads) on any critical element is termed the critical stress ratio $\frac{f_e}{f_a}$. The critical stress ratio is the indicator for evaluating the seismic resisting capability of the structure. Load factors and ultimate capacities are used for concrete design and for plastic design of structural steel.

Site Seismicity for the Method

Several choices are available for the determination of the site seismicity. The simplest is to use figures 1, 2, or 3 on pages 131 and 132 of UBC [2.5], or similar zoning maps which specify the seismicity by designating broad zones in which the value of Z in the base shear formula $V = ZKCW$ is specified. If the maximum Modified Mercalli Intensity (MMI) is specified or determined by others for the site, the Z factor (Z_s) can be determined using the equation "$2 \log 5Z_s = -1.973 + .375$ MMI" where Z_s shall not be greater than 2.0. This equation is not based on derivation but an empirical relationship constructed for this project from the data in Ref. 3.20. The equation produces Z_s values which are consistent with past experience in relating the general effects of various Modified Mercalli Intensity ratings to observed response of buildings having varying design resistances. It is given in the form so that data developed by the methods covered in section 3.4 may also be used for the Approximate Analytical Evaluation Method of the building. Empirically it is found that a good relationship between Z_s and V_s is $25Z_s^2 = V_s$ in which V_s is the soil particle velocity as indicated in equation (3.4.22). Z_s values can be higher than those specified in 1973 UBC but would account for a fault near the site or an important structure which are not explicitly mentioned in 1973 UBC.

C. Rating of Building Resistance to Wind Hazards

Information Necessary for the Method

This method should be used only when plans and specifications are available and it has been determined from the Data Collection Form, see Appendix A, that the plans represent the "as-built" structure. Original calculations, if available, will be of assistance in assessing the resisting capabilities of the various members. It is assumed that personnel familiar with the design of buildings to resist lateral forces will make these analytical evaluations.

Criteria for the Method

The standards used in analyzing the effects of wind or hurricanes on structures is ANSI A58.1-1972 [3.2] except as modified herein. Other loading functions may be used if deemed more appropriate for the site but criteria used should be stated (see section 3.4).

For the purpose of this evaluation, elastic analyses of building response will be compared with material design capacities. Design stresses will be those designated by latest nationally recognized material specifications. In the evaluation, buildings are being analyzed, but not designed. Stresses in structural elements will be checked for the combined effects of wind and vertical loads. Where wind loads are included, the combined stresses may exceed code working stresses by one-third, except where not permitted in the specifications, with the provision that the stresses resulting from design vertical loads alone will not exceed code design stresses.

Determination of Wind Forces on Building as a Whole

A Basic Wind Speed must be assigned to the area by the user. If no other basic wind speed is designated, the values will be taken from figures 3.22 to 3.26 and table 3.10. Unless the building to be evaluated is of unusual importance, the basic wind speed will be determined using a 50-year recurrence interval as shown in figure 3.25. The wind speeds to be used are for the annual extreme fastest mile speed 30 feet above the ground. The building involved will be given an exposure rating corresponding to Exposures A, B, and C of table 5 in 1972 ANSI which converts the basic wind speed to effective velocity pressures (q_F) at varying heights. From the q_F found in this manner, the horizontal force loading can be determined for each major axis of the building; these are for application to the external surfaces of the building.

Response Analysis of the Building as a Whole

In making a horizontal force loading diagram for a building as a whole, step functions may be made with height zones as described in section 6.3.4.1 of 1972 ANSI. This will simplify computational work on tall buildings.

The horizontal loading on windward walls and leeward walls is modified by coefficients C_p as expressed in the 1972 ANSI, table 7. For the building as a whole the effects are additive and for most buildings the applicable wind forces will be 1.4 to 1.3 times the effective velocity pressures (q_F) taken from table 5. This value is the design pressure for application to the building as a whole.

For tall buildings where height exceeds 5 times the least horizontal dimension or for buildings which may have unusually wind sensitive dynamic properties, a dynamic approach to calculating the building's response may be required. This is beyond the scope of this method. However, an example of this method is given in 1972 ANSI, Appendix A6.3.4.1. Figures A2 through A6 provide curves for simplifying the computations. Also, since the structures to be evaluated using the Approximate Analytical Method do not exceed 16 stories in height, it is improbable that many will exceed the 5 to 1 height-width ratio.

In determining the response of the building as a whole, the type of diaphragm system must be considered. A stiff diaphragm will distribute horizontal forces to vertical resisting elements in proportion to their relative rigidities. A flexible diaphragm will distribute forces to vertical elements more nearly proportioned to the tributary exposed wind surfaces. Detailed commentary of diaphragms is given in section 3.3B.

Assuming that the structural resisting system is known from field measurements and plans, and that the wind loading has been determined as described above, the calculations for the adequacy of the building to resist these forces can be made using any of the standard analytical procedures. The lateral loading to each level is determined with positive pressures on the windward side and negative pressures on the leeward side. The path by which these forces are transmitted to the vertical resisting elements is determined and the adequacy of such diaphragm or horizontal bracing system to transmit these forces is checked. A discussion of various types of diaphragms is given in section 3.3B. The vertical resisting elements, either shear walls, moment-resisting frames, or braced frames are then checked for these forces. Lateral forces are applied to these vertical resisting elements at each level and the stresses analyzed. The overturning stresses should be checked, including uplift on foundations. If the original computations are available they can be reviewed to see whether wind forces have been properly computed and distributed and whether the allowable stresses have been exceeded.

Computer programs are available which may be used for wind response on buildings, particularly for tall buildings with moment-resisting frames. If it is desired not to use such a computer check, there are several simplified hand calculation methods frequently used, such as the cantilever method, the portal method, the Spurr method [3.8]. These all make certain assumptions as to points of contraflexure and distribution of vertical load increments from overturning forces. The method that is most applicable to the facility being investigated should be used.

Determination of the Critical Elements

In analyzing a building for the assigned winds, some elements will have higher stress ratios than others. The building element having the highest stress ratio may be the most critical but may be of little importance to the building as a whole. For example, lateral resistance is provided by a large number of moment-resisting frames and one beam column connection is much more highly stressed than the rest. The higher stress of this element would cause redistribution of loads and stresses to other elements. Suppose there were fifty such connections at a particular level and that five of these, when analyzed, had 20% higher stresses than the others. If these five were stressed to yield, the stress redistribution to the other elements would involve only small increases. Therefore, these elements would not be considered the most critical and the critical stress ratio would be based on the lower stressed elements. Conversely, if the lateral forces are resisted by, say, only 4 to 6 vertical elements in a story, and one or two of these were found to have higher stresses than the others, these one or two elements would be considered important and should be listed along with their critical stress ratio. Where elements were found to be stressed beyond their design stress, a re-analysis of the probable path of redistribution of forces is recommended. This may involve the capability of the diaphragm to make such redistribution. If the forces can be redistributed without severe overstressing, the determination of the critical element will be easier to determine.

The usual critical elements for wind resistance are, as in earthquake resistance, the vertical resisting elements (shear walls, braced bays, or moment resistant frames) and the horizontal resisting elements (diaphragms). There is a major difference, however, in that wind forces are applied to exposed surfaces while earthquake forces originate at centers of mass and are proportional to mass. Thus a lightweight exterior wall might have a relatively small earthquake force normal to the wall but would be exposed to wind forces which are independent of the weight of the wall.

Determination of the Critical Stress Ratios

The highest ratio of stress resulting from the wind forces applicable to the site (f_w) to the allowable material design stress (f_a) (including 1/3 increase where permitted but deducting capacity required by gravity loads) on any critical element is termed the critical stress ratio f_w/f_a. The critical stress ratio is the indicator for evaluating the capability of the structure to resist wind forces. Load factors and ultimate capacities are used for concrete design and for plastic design of structural steel.

Analysis of Portions of Building

Both internal and external pressures must be considered on portions of buildings such as roofs and walls. Methods of calculating the internal pressures on roofs and walls are given in 1972 ANSI [3.2] (6.5.3.2.4 and 6.5.4). Corners of walls are exposed to high negative pressures. These corners should be checked as specified in 6.5.3.1 of 1972 ANSI.

Where structures are not enclosed, the roof is somewhat similar to a flat plate and tables 13 and 14 in 1972 ANSI (page 22) give coefficients for determining the net pressures to be used in design. If one end (or one side) or 25% of any exterior wall is open, the structure will be considered not enclosed.

The critical stress ratio is applicable to elements not part of the structural system of a building. For instance, the anchorage of wall cladding can ordinarily be computed. Given the horizontal force on such an element and knowing the distribution of anchors, the load to each anchor can be determined. For example, assume these anchors are bolts placed in tension by lateral forces on the element in question. The ratio of this computed tension to the allowable bolt tension is the stress ratio and is a measure of the adequacy of the anchorage.

Analysis of Anchorage of Exposed Elements

The wind forces (positive and negative) on exposed elements can be determined from 1972 ANSI as previously noted. If the anchorage of such elements is known, the adequacy of the anchorage devices can usually be computed by stress analysis. However, should the initial field examination reveal damage to exterior veneer, appendages or looseness of wall cladding panels which might be caused by corrosion or other chemical deterioration of anchorage, the anchorage should be reviewed in the field to determine whether such a condition is typical or is confined to one location. Also, after the Approximate Analytical Method evaluation has been made and the drawings examined, certain specific items or elements may be found critical and warrant an additional field inspection.

Commentary on Drift

In tall buildings, or other buildings with a high degree of flexibility, drift becomes important. Drift is usually expressed as a ratio of the lateral movement in a story to the story height. Excessive drift may cause damage to non structural elements such as partitions, wall cladding, and glass panels unless these elements are so isolated or cushioned that relative movements of adjacent stories will not exceed the isolation. Stiff, brittle elements such as partitions of unreinforced masonry or glass are more susceptible to this type of damage. Where such brittle elements occur on or near public ways, or from portions of exit enclosures, damage to these elements can be a hazard to human life. Reinforcement of brittle partitions can provide a basketing effect to reduce the hazard from falling pieces. Metal lath on wood or steel studs provides such a basketing effect. Glazing with resilient boundary materials provides a degree of isolation for glass panels. An old rule-of-thumb drift limitation is .0025. For the purpose of this method, wind drift can be ignored on obviously low, stiff buildings. However, the taller, more flexible buildings with moment-resisting frames should be checked for drift, and the effect of this drift considered in its effect on elements other than those of the structural system.

For example, assume that the computed story drift in a 12 ft story height is 0.3 in. Also, assume that an 8 in steel riser pipe is tightly embedded in the concrete floor construction at each level and is fixed at each floor.

Thus,

Pipe - Moment of inertia (I) = 72.5 in^4
- Section modulus (S) = 16.8 in^3
- Modulus of elasticity (E) = 29,600,000 psi
- Allowable stress (f_b) = 26,700 psi

Story height (h) = 144 in
Deflection (Δ) = 0.3 in
Moment (M) = $\frac{Ph}{2}$, where $P = \frac{12\ EI\Delta}{h^3}$
Stress in pipe = $\frac{M}{S} = \frac{6EI\Delta}{S\ell^2}$ = 11,300 psi

This stress is well below the allowable stress and a drift of this magnitude will not break the pipe.

In this same story is a metal stud and plaster partition fastened to the top of the floor below and the bottom of the slab above. The net partition height is 12 ft - 6 in. Limited tests have indicated that such a partition may deform 1/16 in per foot of height with only minor cracking but without failure. Using this limited empirical limitation a drift of 0.75 in would be permissible. A procedure for checking the effect of drift on masonry walls or partitions is given in this section under Earthquake-Commentary on Masonry and Concrete Walls.

D. Rating of Building Resistance to Tornado Hazards

General Considerations

The purpose of this portion of this section is to establish a method for analytical evaluation of a building's resistance to the hazards imposed by tornadoes. Little has been published on design of buildings to resist the tornado hazard. Some excerpts of the available data are presented for assistance in implementing this method:

> "Tornadoes, the most violent of all storms, have long been viewed by many engineers as natural phenomena which should not be considered in design except for possible provision of emergency personnel shelters. However, since 1967, the Atomic Energy Commission (AEC) has required designers of nuclear reactor facilities to carefully consider the effects of tornadoes on such facilities. The AEC has included tornadoes as one of the natural phenomena which the nuclear power plant designer must consider in the design so such facilities can be constructed to successfully withstand the additional forces that might be imposed by a tornado without loss of capability to protect the public." [3.4]

The reader is referred to chapter 2 and also section 3.4 for further general comments concerning tornadoes. However, the following three points are worthy of further comment.

"Tornado Phenomena. The effects of a tornado that are manifested in structural damage are generated from two separate phenomena:

(1) wind, and
(2) changes in atmospheric pressure.

These tornadic effects interact with structures and cause damage through three principal mechanisms:

(1) pressure forces created by air flowing around the structure,
(2) pressure forces created by relatively rapid changes in atmospheric pressure, and
(3) impact forces created by missiles.

Pressure forces are applied to a structure when the flow of air (wind) is interrupted by the presence of the structure. The windward face of a structure will experience pressures acting inward, while the roof, side walls, and leeward face of the structure may experience wind induced pressures which act outward as shown in figure 3.12.

The atmospheric pressure change associated with the tornado is produced by the circular movement of air within the vortex. The minimum atmospheric pressure occurs at the center of the tornado. As a tornado approaches and passes over a structure the atmospheric pressure outside the structure reduced to a minimum value and then returns to ambient. The effects of tornado induced atmospheric pressure change on an unvented structure are illustrated in figure 3.13.

Missiles are generated by extreme winds associated with a tornado. They pose damage threats ranging in degree from breakage of a window glass caused by the impact of roof gravel to stability failure of a structural frame produced by the impact of an automobile." [3.3]

"Tornado - Structure Interaction -- When a structure is engulfed by a tornado field, wind velocities and atmospheric pressure changes do not act uniformly over the entire structure. Furthermore, these interdependent effects do not attain maximum values simultaneously at a point. These two observations have implications in the establishment of wind velocity and atmospheric pressure change criteria for use in structural design. The significance of the observations relates to the size of the structure relative to the diameter of the tornado. One of the methods of developing rational loading for the design of structures is to consider two extreme cases: (1) small structure - large tornado, and (2) large structure - small tornado. By consideration of these two extreme cases it would be possible to consider tornado diameter, structure size, structure orientation, and tornado translational velocity as variables. The results obtained using the two extreme cases would be utilized to develop guidelines for the design of tornado resistant structures." [3.3]

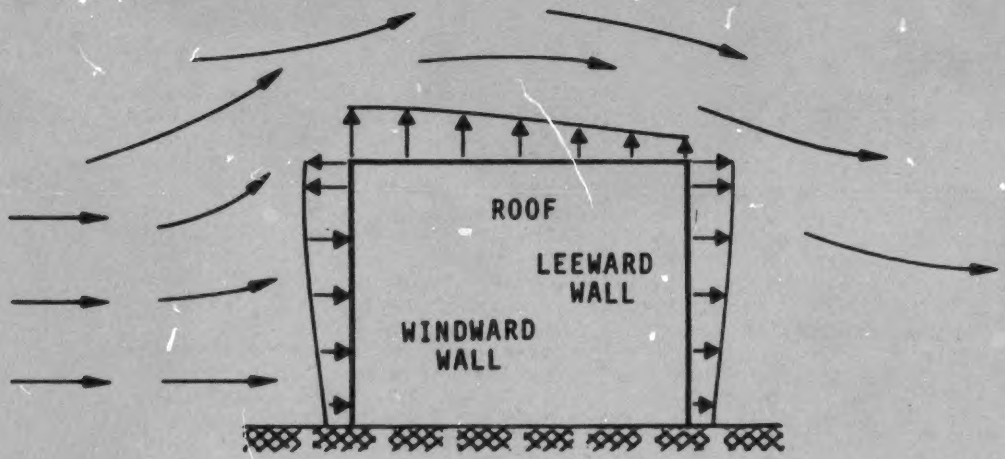

ROOF
LEEWARD WALL
WINDWARD WALL

Figure 3.12 Typical Wind Induced Pressure Forces on a Structure

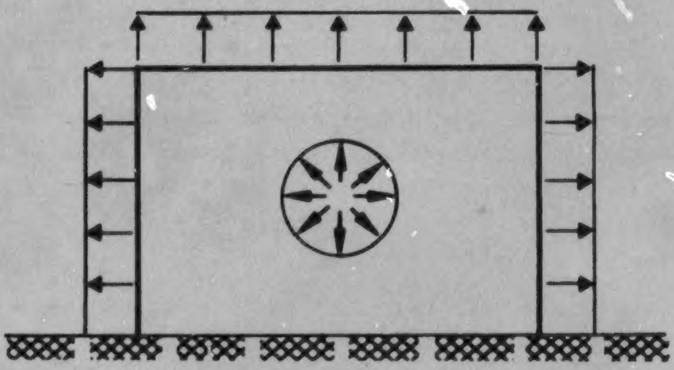


Figure 3.13 Typical Forces on an Unvented Structure Created by Rapid Atmospheric Pressure Change

> "Degree of Protection Anticipated In structures where there is danger of releasing radioactive material to the atmosphere, for example in cases of a nuclear reactor containment vessel or a plutonium processing plant, degree of protection against tornado damage should be absolute. The absolute protection implies no structure damage and no damage to contents of the building from wind, water or missiles. However, in structures such as hospitals, fire stations, civil defense headquarters, etc., some structural damage can be tolerated as long as services are not interrupted. In such cases the degree of protection can be moderate. Researchers at Texas Tech developed design criteria for different degrees of protection for a warehouse. This particular warehouse was designed for tornado protection because unusually expensive material was to be stored in the warehouse." [3.3]

Information Necessary for the Method

It is assumed that plans of the building to be evaluated are available. It is also assumed that the probabilities and frequency of tornado phenomena in the area involved have been determined. Where the probability of occurrence is determined to be low, no tornado evaluation need be made.

Criteria for the Method

For the purpose of the Approximate Analytical Evaluation Method it will be assumed that only moderate protection is required for the building to be evaluated. Therefore a free field velocity of 200 miles per hour and a pressure drop of 1.2 psi will be used. These values are taken from table I in reference [3.3]. Using the formula $P = .0025V^2$ to convert velocity to pressure gives P = 100 psf. The 1.2 psi pressure drop is, converting units, equal to a suction or uplift of 172 psf.

From figures 3.12 and 3.13 it is obvious that the building as a whole is subjected to a total lateral force from both windward and leeward sides. If it is assumed that tornadoes are similar to other high winds, such as hurricanes, with respect to the relationship of pressures on windward and leeward sides, one finds these coefficients of the velocity pressures to be 0.8 and either 0.5 or 0.6, respectively; depending on the height-width ratio of the building. Thus the total lateral force on a building subjected to tornadoes for a moderate degree of protection will be 100 x (0.8 + 0.5 or 0.6) = 130 or 140 psf. These coefficients are taken from table 7 of 1972 ANSI and apply to enclosed structures.

There are probably very few buildings that will be undamaged if in the direct path of a strong tornado. The least likely to be severely damaged will be heavy reinforced concrete or reinforced masonry vault like structures one or two stories in height, with relatively heavy and solid walls. Taller buildings designed to resist hurricanes may have limited damage but probably will not collapse unless they are of unusual configuration or have large roof overhangs or open sides. Light buildings of wood frame or steel frame and metal sidings have been known to have been torn from their foundations and blown considerable distances. It is possible, however, to provide such light buildings with some resistance to winds by proper anchorage to foundations to resist uplift.

The structural systems of some buildings designed for earthquake may be capable of resisting forces created by tornadoes. For example, a warehouse 100 ft x 100 ft and 20 ft high with concrete roof and walls has been designed for an earthquake force of 0.133g. If the walls weigh 100 lbs per sq ft and the roof dead load is 100 psf, the total design horizontal force for an earthquake in either direction would be about 1,530 lbs per linear foot at the roof line as compared to 10 x 140 pounds or 1,400 pounds per linear foot for the moderate tornado design force.

Analysis of Building as a Whole

It should be obvious that many buildings will not warrant analytical evaluation. A short perusal of the plans of a building should determine whether a roof system has the weight, reverse load capacity, and anchorage to resist the extreme uplift forces associated with tornadoes, or whether an entire building is heavy enough to resist such forces. A quick look at the foundation details should show whether any special hold-down provisions have been used. Pile or caisson footings will have good potential uplift characteristics if anchored to foundations. For example, in a steel frame building, the presence of many large anchor bolts from base plate to concrete footing would indicate that uplift forces were probably considered in the design. Some concrete piles may have no reinforcing bars or only a single small reinforcing bar extending down from the pile cap into the pile a short distance. This would indicate that little or no consideration had been given to uplift forces. Deep basements will have good hold-down characteristics. In general, therefore, a light, one-story structure without special hold-down foundation characteristics can be given an inadequate rating without analytical calculations beyond a very rough assessment of weight as indicated in the Field Evaluation Method, section 3.2.

Light roofs of wood or steel are usually designed for a live load of not over 30 psf. For tornadoes, structures are to be checked for an uplift force of at least 172 psf. It will be found in most such cases that the net uplift is several times the design dead load. Such roofs can be considered inadequate to resist maximum tornado forces. This reasoning may not be true in areas where a heavy snow load is used in design.

If a building has been evaluated for wind and given a poor rating, it will be considered to be inadequate to resist tornadoes. The ability of roof systems, designed only for gravity loads, to resist reversals from uplift needs discussion. Steel beams with their compression flanges braced by the deck under usual gravity loads may have lower flanges unbraced and subject to compression buckling under uplift loads. Deep concrete beams, wood girders, and trusses need to be checked and analyzed for their capacity under such reversals. Even though these reversals may be only for a few seconds, the effect of such reversals must be considered and the roof anchorage details checked.

So far, these comments have been related primarily to uplift. The wall capacities must be checked for direct horizontal positive and negative force. The floor and roof systems must be checked for adequacy as diaphragms to transmit lateral forces to the vertical resisting elements. Once again the anchorage is of major importance. Anchorage of walls to footings should be checked for capacity to resist sliding combined with vertical uplift and overturning. The footings themselves should be checked for sliding resistance, uplift, and overturning forces. In checking these calculations, the purpose is to determine the ratio of stresses resulting from the imposed tornado loads to the capacity of the structure.

In each of the various resisting systems, such as roof, floors, shear walls, or moment-resisting frames, there may be one or more critical elements which will fail before the other elements. Care must be taken not to derate a building because of one non-important element. Where the failure of such an element would not cause failure of a system, but would only cause minor redistribution of loads, such a member would not be a critical element. Reference is made to further discussion of critical elements in this section.

Analysis of Portions of Building

It should be obvious that with positive and negative pressures of the magnitude encountered in tornadoes, such building items as exterior doors and windows, wall cladding, exterior appendages, and balconies will be very vulnerable and the average installation and anchorage of such items will not be adequate but will be checked to determine the critical stress ratio. Glass panes, unless designed especially for such pressures, as to size, thickness and strength must be checked for their adequacy for resisting tornado wind pressures.

3.4 DETAILED ANALYTICAL EVALUATION METHOD

A. Introduction

This section discusses the methodology and rationale involved in the development of a computer program that estimates the damageability of buildings under the following natural conditions:

- Earthquake
- Wind - General
- Tornado and Hurricane.

The methodology has intentionally been presented in a user oriented manner regarding the:

- Determination of environmental loads
- Definition of structural models and response computation
- Estimation of potential damage.

The method presented is essentially state-of-the-practice when balancing the uncertainties in the various fields against the value of detailed analysis at the most elementary level. Reference [1.4] presents a collection of various state-of-the-practice papers.

The section presents the methodology behind a modular computer program which brings together the many aspects of the damageability prediction problem. The computer program may be readily updated to incorporate new developments in any selected module.

The reader must realize that by the very nature of structural engineering and more specifically, the architect-structural engineer relationship, that one computer program cannot hope to structurally model all possible building types and still be economical to use. Therefore, a procedure is presented which is appropriate for a reasonably large class of building structures. In particular, the program can be used to estimate the damageability to the following structural types:

- Braced and unbraced steel frame buildings
- Concrete shear wall and shear wall plus frame buildings
- Bearing wall buildings
- Long span roof structures.

All buildings are assumed to act in a two-dimensional or inplane manner and hence, buildings with significantly irregular floor plans (e.g., T or L shaped) or structural framing, cannot, with a high degree of confidence, have their damageability assessed with this program. Also, damage in buildings for which soil-structure interaction is important cannot be estimated with high confidence. Only an experienced structural and/or soils engineer can establish whether the building under consideration is in one of the two latter categories.

The developed computer program utilizes the professional experience of the engineer. The engineer must provide judgmental input as to the (1) quality of building construction, (2) deformation for the structural components to yield and failure, (3) completeness of the site description properties, and more. Therefore, the computer program enables the engineer to quantify his professional experience about many component aspects of the problem without having to specify how they all interrelate in establishing building damageability.

A direct comparison of this method with the two previously discussed evaluation methods is not simple. The Detailed Analytical Evaluation offers the engineer a computer program with many options. It is possible to obtain damage estimates for a building using this program in a matter of minutes or it can take days depending upon the complexity of the structural model. Also, much of the required input for the procedure can be obtained using the judgmental values of engineers documented in this section or the establishment of these input values may require days of study so as to obtain the best estimated values for the building under study. Philosophically the Approximate Analytical and Detailed Analytical Evaluation Methods differ in two respects. One, the Approximate Analytical Method is based upon a stress damage evaluation. The stress in critical elements is calculated and compared with code stress levels. The methodology discussed in this section relates structural and most nonstructural damage to interstory drift. Local member stresses are not calculated. Earthquake nonstructural damage is related to an effective floor MMI through an estimate of floor response. The second major difference is the sophistication of the analytical building model. A finite element type model is used in the latter method whereas a more simple model is usually used in the former method.

B. Natural Hazard Loading - Earthquake

General Comments

The method used for generating earthquake loads on buildings entails four basic steps:

1. Determination of seismicity, A, as a function of geographic location. The Richter magnitude, M, of a representative earthquake is derived from the seismicity of a particular site.

2. Determination of an effective hypocentral distance, r, which locates the representative earthquake with respect to the building site. Computation of r involves the attenuation properties of the Earth's crust in the vicinity of the site.

3. Specification of a hard-rock particle velocity spectrum, $V_{HR}(T)$, for the site. This too will involve the attenuation properties of the Earth's crust.

4. Generation of a soil amplification factor, $(DAF)_s$, for the site which, when multiplied by the hard-rock velocity spectrum results in a ground site particle velocity spectrum, $V_{site}(T)$.

The ground site spectrum characterizes the dynamic environment of the building and will be referred to as the "earthquake load." A flow diagram depicting this sequence of operations is shown in figure 3.14.

The procedure used to develop the ground site spectrum parallels that presented by Algermissen [1.4]. It does not, however, explicitly consider proximity of the site to known faults. Efforts are underway by the U.S. Geological Survey to develop earthquake risk maps incorporating this factor.

Recognizing that a professional consensus does not exist relative to the most appropriate procedure for obtaining a ground site spectrum, an option was included in the computer program for the Detailed Analytical Evaluation Method to permit the user to bypass the computation of earthquake loads described in this section and input directly a ground particle velocity spectra (see Section 2.1.1.3 Appendix E).

The earthquake load generation approach is empirically based wherein certain relationships are derived by dimensional analysis and curve fitting of observed earthquake data. The seismicity at a site is a parameter which represents the amount of seismic activity (number of earthquake events per year) within a specified radius of the site. This area defined by this radius is referred to as the "felt area" about a given site. The radius which defines the area is a function of the attenuation properties of the earth's crust within that region. The seismicity at a site is defined in accordance with all available historical earthquake data [3.12], [3.13]. Typically, these references provide the date of earthquake occurrence, its location, and its magnitude or intensity.

Other recorded data provides the maximum ground acceleration, velocity and displacement experienced at a sight for earthquakes occurring within the felt area. These data are not available for all parts of the country, but coupled with known geological characteristics, can be extrapolated and used as the basis for establishing attenuation characteristics for the earth's crust. Since measureable ground motion characteristics include the effects of local soil conditions, prior to developing attenuation characteristics a soil model must be generated to relate the site ground motion to the motion of basement rock which underlies the site.

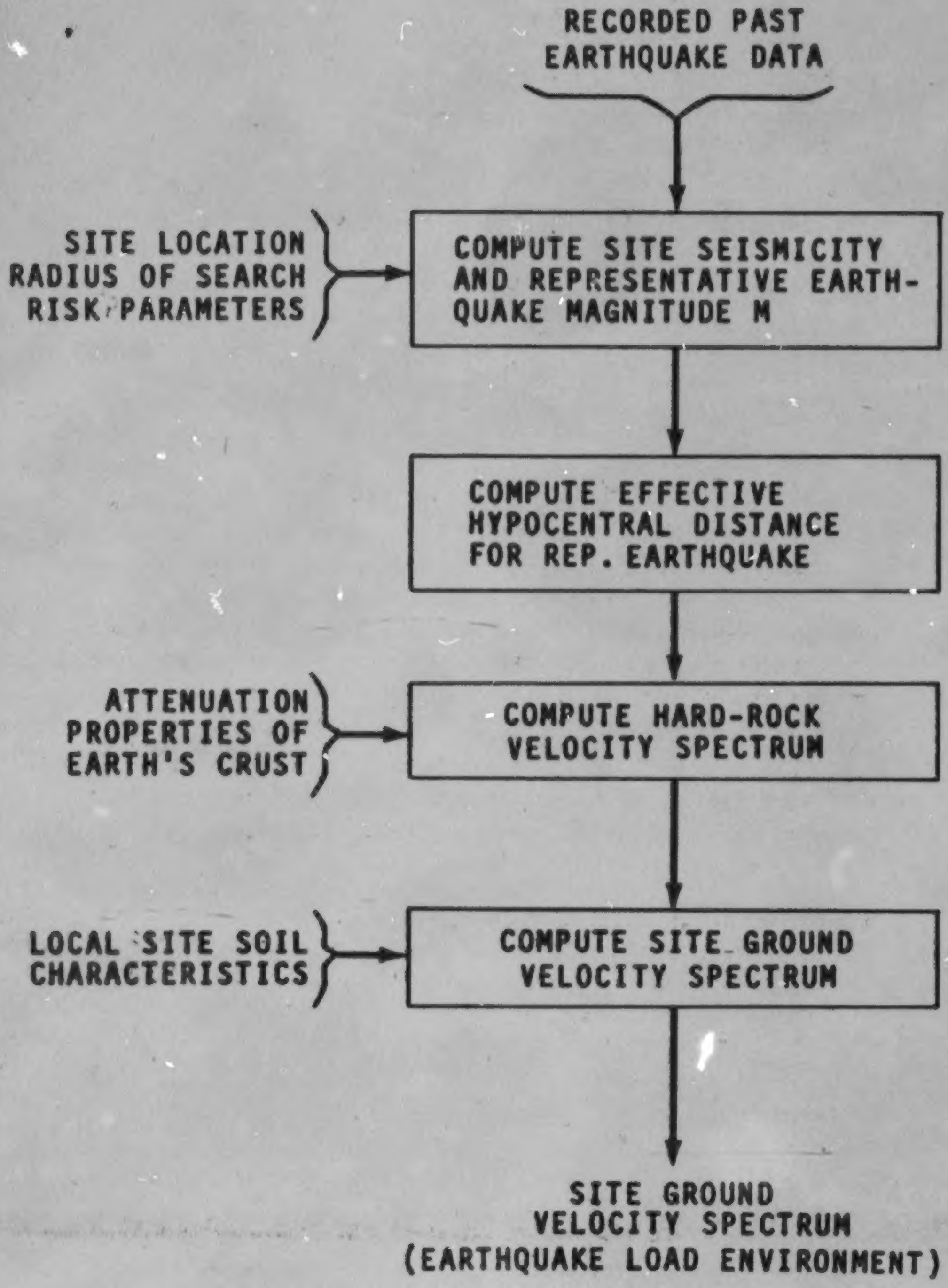

RECORDED PAST EARTHQUAKE DATA
SITE LOCATION
RADIUS OF SEARCH
RISK PARAMETERS
COMPUTE SITE SEISMICITY AND REPRESENTATIVE EARTHQUAKE MAGNITUDE M
COMPUTE EFFECTIVE HYPOCENTRAL DISTANCE FOR REP. EARTHQUAKE
ATTENUATION PROPERTIES OF EARTH'S CRUST
COMPUTE HARD-ROCK VELOCITY SPECTRUM
LOCAL SITE SOIL CHARACTERISTICS
COMPUTE SITE GROUND VELOCITY SPECTRUM
SITE GROUND VELOCITY SPECTRUM (EARTHQUAKE LOAD ENVIRONMENT)

Figure 3.14 Generation of Earthquake Load Environments

The remaining paragraphs of section 3.4B are organized according to the following four steps. First, historical data is used to determine seismicity A as a function of geographical location. An equation is presented which relates earthquake magnitude to frequency of occurrence with A as a parameter. In order to determine the dynamic environment of a building due to earthquake of magnitude M, the earthquake hypocenter must be located relative to the site. Therefore, the section contains a description of the method used to determine an effective hypocentral distance r. Next, a description is presented of how a hard-rock velocity spectrum is obtained for a site using available records of maximum acceleration, velocity and displacement corresponding to particular earthquakes of known magnitude and distance from the recording site. Finally, various techniques available are presented for generating soil models and corresponding amplification factors for computing earthquake loads from hard-rock spectra.

United States Seismicity

Earthquake loads derived herein for a particular site are based on past earthquake data. Some areas of the country have exhibited a great amount of seismic activity while others have exhibited little or none. Thus, the distribution of seismicity throughout the country is of fundamental importance. A tabular format has been chosen for the presentation of seismicity characteristics throughout the country. The continental U.S., Alaska and Hawaii have each been subdivided into one-half by one-half degree grid areas (4360 for the Continental U.S., 2516 for Alaska and 92 for Hawaii)as shown in figures 3.15 to 3.17. For each grid area this section discusses how one calculates a mean seismicity, $\bar{A}$, and a seismicity standard deviation, σ_A, based on a statistical analysis of all available earthquake data. Values of $\bar{A}$ and σ_A are given in Appendix H for each grid area. These values are based on a statistical analyses of all available earthquake data.

This treatment of the past earthquake data is based on an approach proposed by Wiggins and Moran [1.1], and involves the seismicity relationship

$$\log_{10} N = A - bM \tag{3.4.1}$$

where

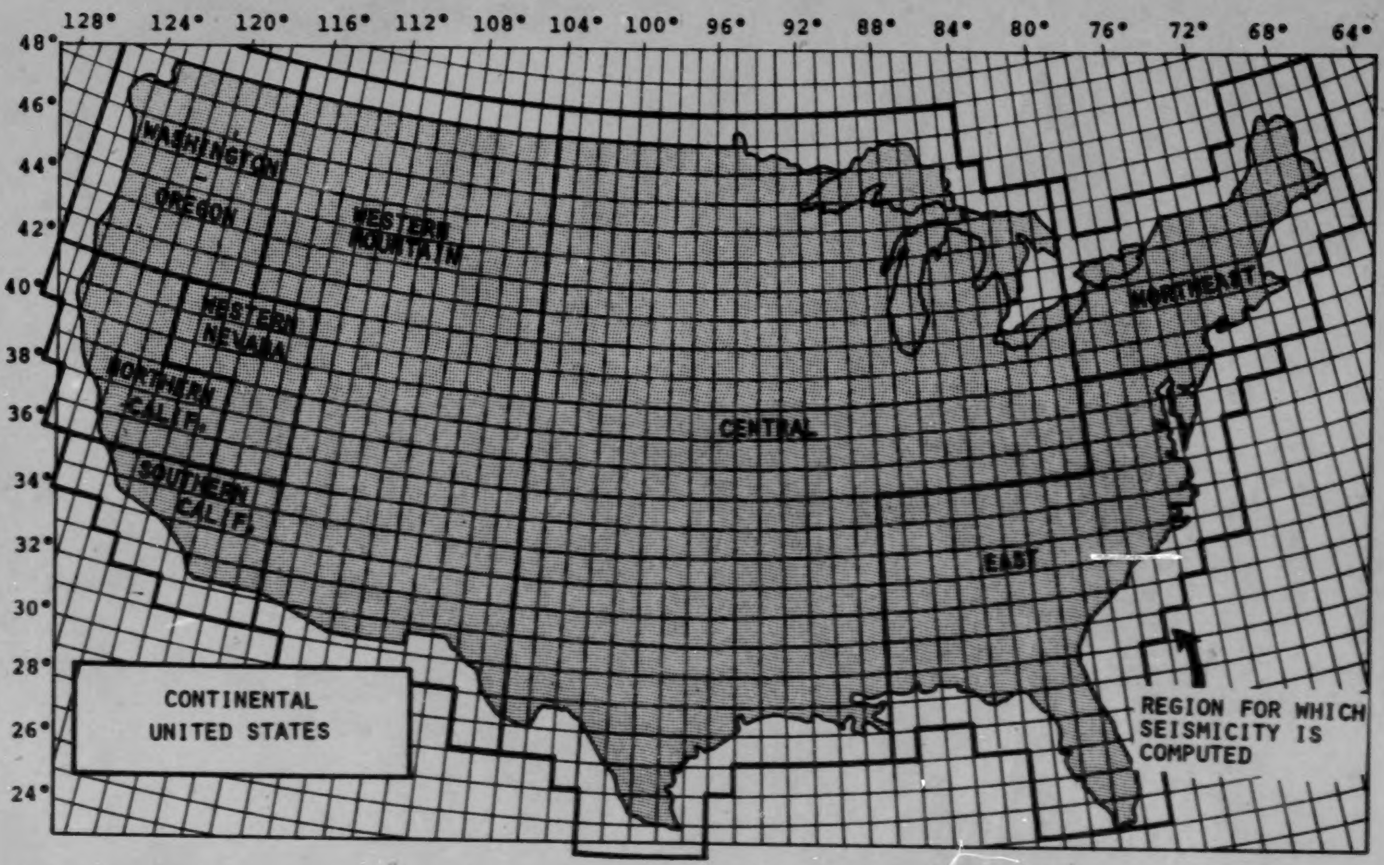
A ≡ seismicity at a given site

M ≡ Richter magnitude

N ≡ frequency of occurrence (events per year) of earthquakes of magnitude M or greater

b ≡ a distribution characteristic governing the relative frequency of earthquakes of different magnitude

(1/N) ≡ earthquake return period



128°
124°
120°
116°
112°
108°
104°
100°
96°
92°
88°
84°
80°
76°
72°
68°
64°
48°
46°
44°
42°
40°
38°
36°
34°
32°
30°
28°
26°
24°
WASHINGTON - OREGON
WESTERN MOUNTAIN
WESTERN NEVADA
NORTHERN CALIF.
SOUTHERN CALIF.
CENTRAL
NORTHEAST
EAST
CONTINENTAL UNITED STATES
REGION FOR WHICH SEISMICITY IS COMPUTED

Figure 3.15 Seismicity Grids for the Continental U.S.

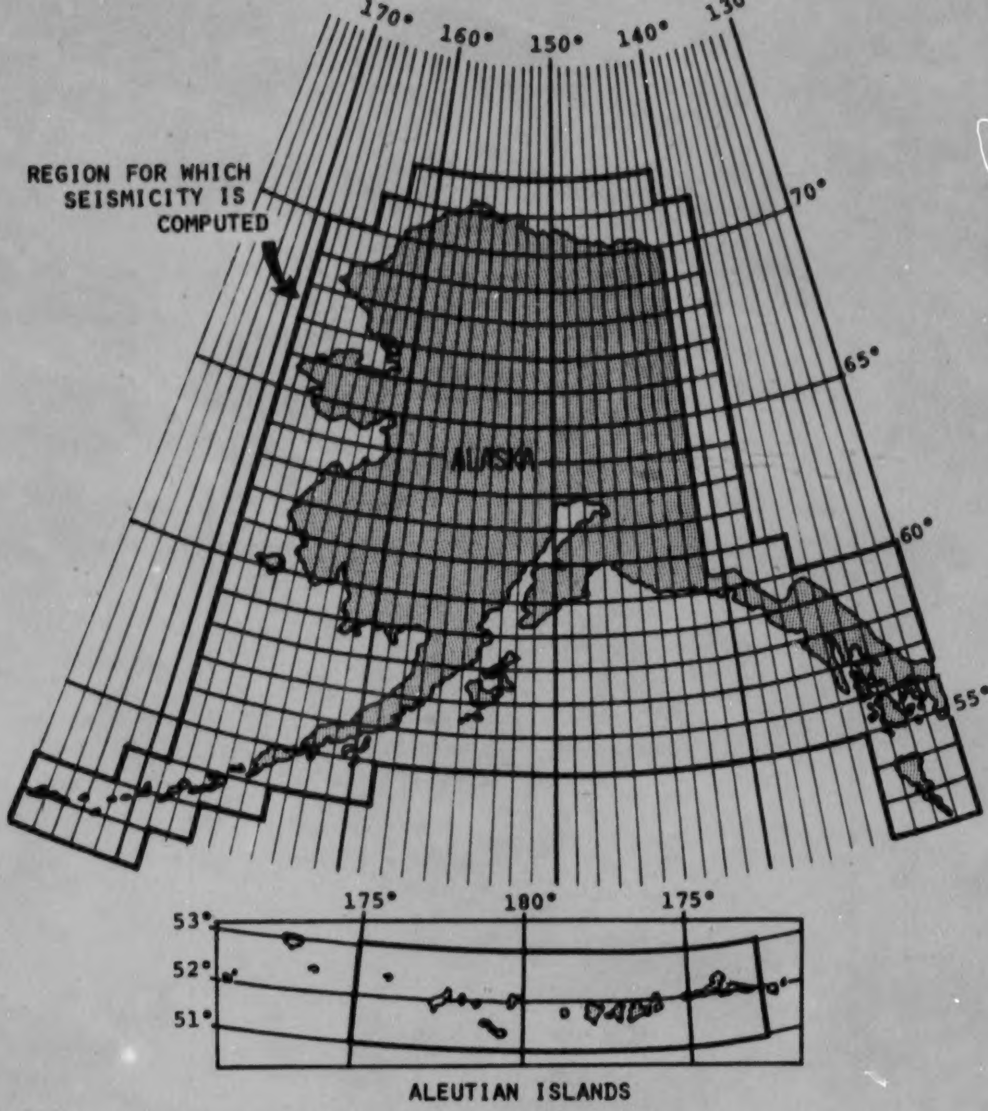

170°
160°
150°
140°
130°
REGION FOR WHICH SEISMICITY IS COMPUTED
70°
65°
60°
55°
ALASKA
175°
180°
175°
53°
52°
51°
ALEUTIAN ISLANDS

Figure 3.16 Seismicity Grid for Alaska

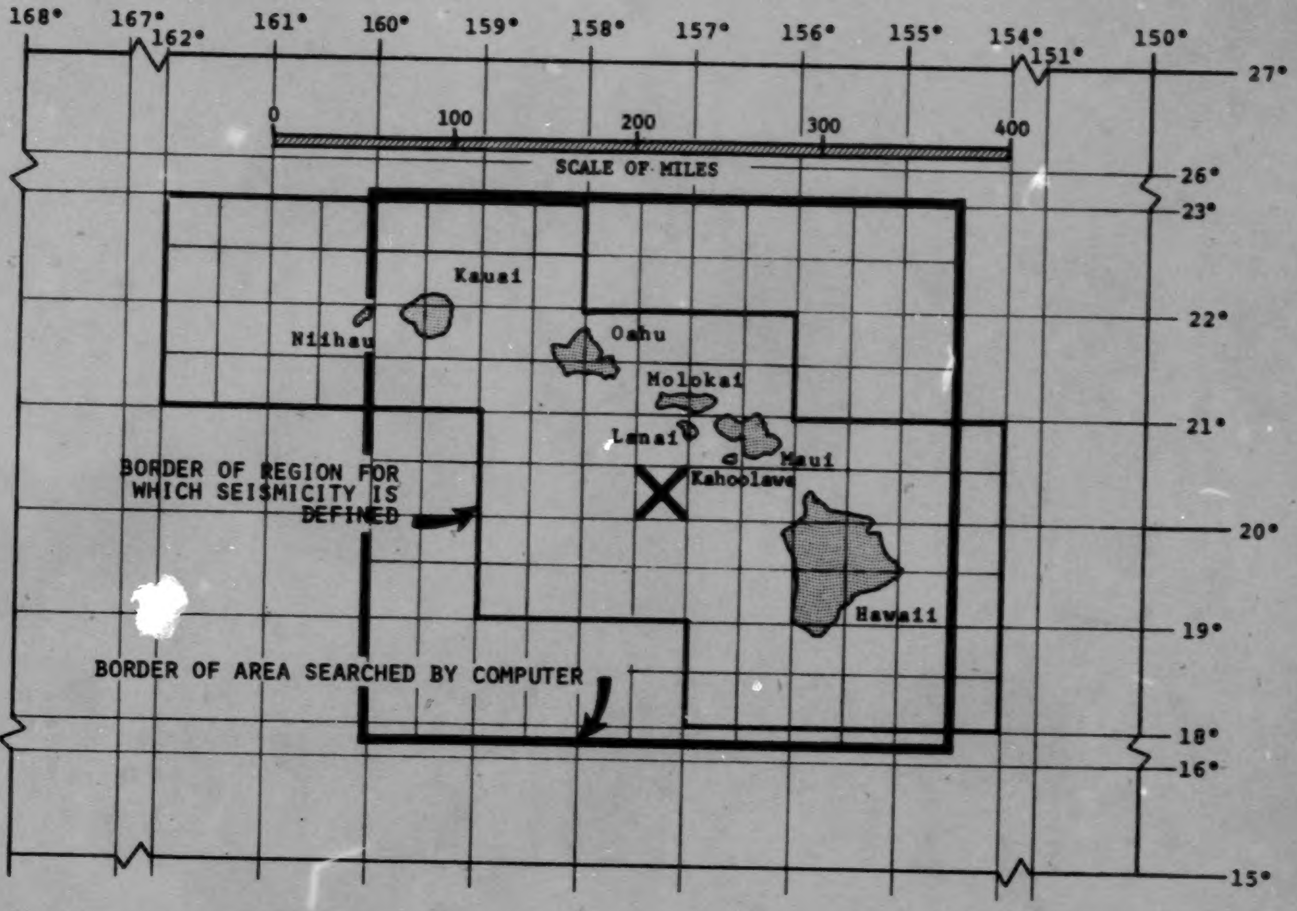

168°
167°
162°
161°
160°
159°
158°
157°
156°
155°
154°
151°
150°
27°
26°
23°
22°
21°
20°
19°
18°
16°
15°
0
100
200
300
400
SCALE OF MILES
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Kahoolawe
Hawaii
BORDER OF REGION FOR WHICH SEISMICITY IS DEFINED
BORDER OF AREA SEARCHED BY COMPUTER

Figure 3.17 Radius of Search for Finding Seismicity (A) of Typical Grid

The value of $b = 0.9$ appears to be a constant independent of location as evidenced by the following:

(1) World Seismicity [1.1] reveals $b = 0.88$.

(2) Recent work by Nuttli [3.14] reveals that $b = 0.927$.

(3) Bollinger [3.15] derived a value for $b = 0.87 \pm .12$ for all shocks in the Eastern United States.

(4) Chinnery [3.16] and Gordon [3.17] obtained similar results as above.

Equation (3.4.1) allows one to compute the seismicity A at a particular site in the United States in the following manner:

Step 1: Input of Earthquake Data Sources

The earthquake data bank consisted of two types of information:

a) Recent (NOAA) Data - these are earthquake data recorded since 1961 (see [3.13]) which give complete information about each earthquake including its location and Richter magnitude. These data are assumed to be a complete record of seismic activity of Richter magnitude 3.5 or greater over the 12 year period, 1961-1973.

b) Historical Data - these are earthquake data taken prior to 1961 (see [3.12]) and include data recorded as long as 323 years ago in the Northeast region of the United States. Information about each earthquake includes date, location, Modified Mercalli Intensity (MMI)and felt area (area throughout which earthquake was felt). Because of the non-scientific measurements used for this type of data (Modified Mercalli Intensity) and knowledge that smaller earthquakes may have not been recorded due to sparsity of population in some areas, the historical data were modified in the following two ways:

- Intensity Modifications for Adjustment to Epicenter - From data published by Wiggins [3.18], attenuation equations (found from regression techniques) have been developed to relate the Modified Mercalli Intensity at a site, to magnitude and hypocentral distance in the western region of the United States, namely California (Ferndale and El Centro) where 16 significant earthquakes were recorded on strong motion accelerographs at each site. The resulting equation for the western region (longitude ≥ 105°) of the United States is:

$$MMI = 2.786 + 1.5M - 3.742 \log_{10} r \quad (3.4.2)$$

where

r = hypocentral distance (miles)

MMI = Modified Mercalli Intensity at site of interest

M = Richter magnitude at epicenter

The value for the coefficient to M was forced to be 1.5 in equation (3.4.2) since Gutenberg and Richter [3.19] give the relationship that $M = 1 + 2/3\ \mathrm{MMI}_0$ (MMI_0 = maximum Modified Mercalli Intensity at the epicenter).

Using relationships presented by Algermissen in [1.4, page 119], a similar attenuation equation can be developed for the eastern region of the United States. The value of the coefficient of M in the equation was again forced to be 1.5, since various tests of the data and theoretical examinations for energy revealed that this simple relationship held for all parts of the country (for shallow earthquakes) as well as for California. The resulting equation for the eastern region is:

$$\mathrm{MMI} = 1.622 + 1.5M - 2.61 \log_{10} r \qquad (3.4.3)$$

Equations (3.4.2) and (3.4.3) can be used to express MMI_0 in terms of the felt area by substituting an isoseismal value of 4 for MMI (lowest intensity felt), replacing M with ($1 + 2/3\ \mathrm{MMI}_0$) and noting that Area = πr^2. The two resulting equations are:

Western Region (longitude ≥ 105°)

$$\mathrm{MMI}_0 = -.286 + 1.871 \log_{10} \left[\frac{\text{(Area felt)}}{\pi}\right] \qquad (3.4.4)$$

Eastern Region (longitude < 105°)

$$\mathrm{MMI}_0 = .878 + 1.31 \log_{10} \left[\frac{\text{(Area felt)}}{\pi}\right] \qquad (3.4.5)$$

Therefore, for historic data [3.12] where the subjective Modified Mercalli Intensity is used, a comparison is made for each earthquake between the intensity recorded and the intensity given considering the area felt via equations (3.4.4) and (3.4.5). The larger of the two values is kept.

- Intensity Modifications for Low Population Density - The historic earthquake data were further modified by multiplying the number of MMI_0 values reported or computed from felt area reports (whichever was the larger) by the factors in table 3.5. These factors were based on population density statistics given in various World Almanacs and Statistical Abstracts of the United States. It was assumed that $\mathrm{MMI}_0 = 9$ and above would be noticed since the beginning of recorded time. The number of events less than $\mathrm{MMI}_0 = 9$ was increased by relating the ratio of population densities over time before 1930 to the felt area.

Table 3.5 ESTIMATED HISTORIC EARTHQUAKE MULTIPLICATION FACTORS

Region	Year of First Observation	Number of Years to 1961	Multiplication Factors for MMI							
			XII	XI	X	IX	VIII	VII	VI	V
Northeastern	1638	323	1	1	1	1	2	2	3	3
Eastern	1663	298	1	1	1	1	2.3	2.3	4	4
Central	1699	262	1	1	1	1	2.3	2.3	4	4
Western Mountain	1852	108	1	1	1	1	2	2	5	5
Washington-Oregon	1841	120	1	1	1	1	2.3	2.3	4	4
Alaska	1786	175	1	1	1	1	3.2	3.2	7	7
Hawaii	1834	127	1	1	1	1	2	2	4	4
So. California	1769	192	1	1	1	1	2.5	2.5	5.3	5.3
No. California	1808	153	1	1	1	1	2.5	2.5	5.3	5.3
Western Nevada	1860	102	1	1	1	1	2.5	2.5	5.3	5.3

After obtaining the modified MMI_0 intensity values for the historical data, the final conversion from MMI to M was made using the equation $M = 1 + 2/3\ MMI_0$.

Step 2: Creating N versus M Cumulative Histograms

With the earthquake data properly modified and divided into two sets (recent and historical), each earthquake may be placed into the appropriate grid area based on its latitude and longitude (and then into one or more storage bins within that grid as shown in table 3.6). The parameter N denotes the number of earthquakes above a certain magnitude divided by the time period spanned by the data. For example, if one is considering data showing the occurrence of ten earthquakes of magnitude greater than or equal to Richter Magnitude 5.5 within a period of ten years, one would place ten earthquakes in bin number 5 and divide by ten to obtain N = 1. If one does this for each bin and then forms a Histogram, the results might appear as shown in figure 3.18.

Table 3.6 STORAGE BINS FOR TYPICAL GRID AREA

Bin Number	Earthquake Magnitude M Greater than:
1	3.5
2	4.0
3	4.5
4	5.0
5	5.5
6	6.0
7	6.5
8	7.0
9	7.5
10	8.0

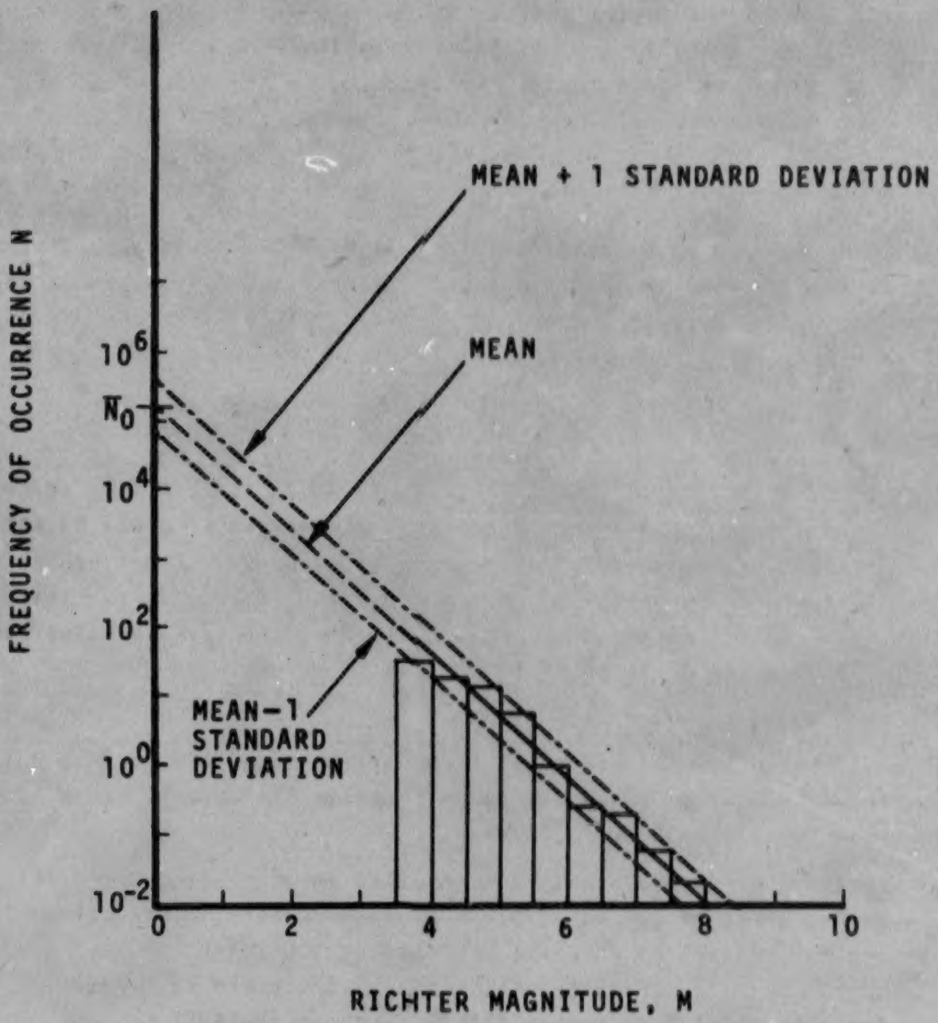


Figure 3.18 Cumulative Frequency of Occurrence Histogram

A regression fit to the cumulative frequency of occurrence data using equation (3.4.1), with the slope b set at b = 0.9, will produce a mean value, $\overline{N}_o$, for the intercept of the regression line and the vertical axis. The mean seismicity, for the grid, $\overline{A}$, is now defined to be

$$\overline{A} \equiv \log_{10} \overline{N}_o \qquad (3.4.6)$$

The corresponding standard deviation of the grid seismicity is denoted σ_A. The value of σ_A is obtained directly from the previously discussed regression fit. Although the grid seismicity, A, has been treated as a random variable in determining $\overline{A}$ and σ_A, it will be convenient to henceforth consider A to be deterministic in the sense that

$$A = \overline{A} + n\sigma_A \qquad (3.4.7)$$

To amplify this point, A, as defined in (3.4.7), is hereafter referred to as the grid's Engineering Seismicity. The parameter n may be set equal to zero in which case one's confidence, based upon a normal probability density function, would be 50 percent that the seismicity for that grid (i.e., site) does not exceed A. If n = 2 the corresponding confidence level would be 95 percent.

Step 3: Define Radius of Search

In calculating the seismicity A, it is appropriate to determine which earthquake events in the vicinity of the site are able to cause damage. This is done as follows:

a) Define the maximum probable earthquake for the site, M_{max}, as having a return period (1/N) equal to 400 years. This value may be compared to Gordon's estimate of 450 years for New England [3.17] and Nason's estimate of 220 years or longer for a specific location on the San Andreas fault [1.4]. Then from equation (3.4.1), assuming that the seismicity of the site does not change with time, one may write

$$\log_{10}N_H + bM_H = \log_{10}(1/400) + bM_{max} \qquad (3.4.8.a)$$

If M_H is the magnitude of the largest earthquake recorded during historic time $T_H = 1/N_H$, then one finds that

$$M_{max} = M_H + \frac{1}{b} \log_{10}(400/T_H) \qquad (3.4.8.b)$$

b) By using M_{max} from equation (3.4.8), the attenuation equations (3.4.2) and (3.4.3) which relate magnitude to hypocentral distance for the western and eastern regions of the United States, and by specifying that a value of intensity below MMI = 6.7 will cause no damage (see [3.11], Appendix H), a radius is found beyond which the maximum probable earthquake for a region will cause no damage even if it occurs. This gives

Longitude ≥ 105°

$$\log_{10} r_s = \frac{2.786 + 1.5M_{max} - MMI}{3.742} \tag{3.4.9.a}$$

For regions: Washington, Oregon, Northern California, Western Nevada, Southern California, Alaska and Hawaii.

Longitude < 105°

$$\log_{10} r_s = \frac{1.622 + 1.5M_{max} - MMI}{2.61} \tag{3.4.9.b}$$

For regions: Central, North and East

where

r_s = radius of search beyond which the maximum probable earthquake specified for each region will cause no damage.

Table 3.7 gives the radius of search for each of the regions listed above. It is noted that on the computer, the search was made more efficiently and economically by converting the search area to a square having the same area as the circle of influence. Thus, $\log_{10}(4/\pi)$ was subtracted from the above equations to obtain the radius of search for each of the regions listed in table 3.7. It is noted that earthquake data were stored in the grids beyond the dark line boundaries shown in figures 3.15 to 3.17 to accommodate searches extending past these boundaries.

Numerical Example for Computing A

Having divided the past seismic data into two separate sets (historic and NOAA), creating the N versus M histograms for each grid shown in figures 3.15 - 3.17, and defining a radius of search for each region, the seismicity (assumed constant in each 1/2° by 1/2° grid) can be calculated for all grids using the historical and NOAA data separately.

Table 3.7 DISTANCE OF SEARCH FOR AN EQUIVALENT SQUARE FOR VARIOUS REGIONS OF THE UNITED STATES

Region	MMI_o(max) Historic (MMI)	Years of Data	M_H** (400 yr)	Distance Search for a Square (mi)
North Eastern	9	335	7.1	105
Eastern	10	310	7.8	264
Central	10	274	7.8	264
Western Mountain	10	120	8.3	158
Washington/ Oregon	9	132	7.5	76
Northern California	10.8	165	8.5 (8.63)*	191
Southern California	11	204	8.5 (8.65)*	191
Western Nevada	11	114	8.5 (8.94)*	191
Alaska	11.1	187	8.5 (8.77)*	191
Hawaii	10	139	8.2	145

*Computed values. 8.5 is assumed upper bound magnitude for the U.S.

**$M_H = 1 + 2/3\ MMI_o(\max)$

A sample grid area in Hawaii (marked by an X in figure 3.17) is used to illustrate the procedure for computing A.

From table 3.7, the radius of search for Hawaii is found to be 145 miles. Therefore, a square is created around the grid marked X that is approximately 290 miles across (approximate because if the radius of search falls in the middle of a grid it is extended out to the end of it). This square is indicated by bold lines in figure 3.7.

For each set of data (historic or NOAA) used, the N's for each M are summed over all grids falling within the area of search. (In this example there are 121 grids over which to sum). This allows N versus M histograms to be created for the entire area of search, similar to that shown in figure 3.18. Then a line with -0.9 slope is drawn through a point at the top center of each rectangle in the histogram. Each line so drawn defines an intercept A_i and this intercept corresponds to a seismicity value appropriate for a certain magnitude of past earthquakes, i.e., that magnitude which corresponds to that rectangular grid in the histogram. The average seismicity for the grid is then found by averaging the A_i's, i.e.,

$$\bar{A} = \frac{1}{n}\sum_{i} A_i \qquad (3.4.10)$$

where the index i (corresponding to the Bin No. in table 3.6) ranges over all of the bins.

The standard deviation of grid's seismicity is found from the equation

$$\sigma_A = \sqrt{\frac{1}{n}\sum_{i} (A_i - \bar{A})^2} \qquad (3.4.11)$$

Having obtained $\bar{A}$ and σ_A, an Engineering Seismicity, $A = \bar{A} + n\sigma_A$, may be established after specifying a value for n.

A complete summary of the United States Seismicity is contained in Appendix H.

Definition of Earthquake Risk Parameters

Having computed $\bar{A}$ and σ_A for all of the grid areas shown in figures 3.15 to 3.17, one is in a position to establish representative earthquakes, for use in computing earthquake loads for buildings, for any part of the country based on historical data. There are two ways to do this. The first is to specify a return period, 1/N, for the representative earthquake. In this case, the earthquake represents the maximum earthquake likely to occur during a return period T = 1/N. Its magnitude is given by

$$M = \frac{1}{b} (A - \log_{10} N) \qquad (3.4.12)$$

where

$$A = \bar{A} + n\sigma_A$$

and n is specified by the engineer according to a desired level of confidence. The set value of n establishing the percent confidence that M will not be exceeded during the time T.

An alternate way to compute M is to recognize that the random occurrence of earthquakes of magnitude M or greater can be described by a Poisson process where the probability of non-occurrence, p, is given by

$$p = e^{-LN} \qquad (3.4.13)$$

and L denotes the lifetime of the building. Thus, a representative earthquake of magnitude M may be established such that the probability of M not being exceeded in a period of L years is p. For example, if the life of the building is 20 years (i.e., L = 20) and an acceptable probability of non-occurrence is 0.90 (i.e., p = 0.90) then the corresponding return period, T, is obtained from (3.4.13) is

$T = (1/N) = -L/\ln (p) = 20/0.1045 = 191$ years and
$N = 0.00522$

If the engineering seismicity, A, is equal to 5.0 then the computed Richter magnitude is

$$M = \frac{1.0}{0.9} (5.0 - \log_{10} .00522) = 8.10$$

Effective Hypocentral Distance

In order to estimate the ground motion at the basement rock underlying a site, both the magnitude and distance of a representative earthquake are required. This section explains how the latter is obtained using past earthquake data. The distance from a particular site to the source of a seismic disturbance is called the hypocentral distance and is denoted by r. Since the source of an earthquake is usually some distance below the surface of the earth's crust, the hypocentral distance is defined as the hypotenuse of the right triangle shown in figure 3.19, assuming a flat earth for the relatively small distances involved. It is furthermore assumed that the focal depth of all earthquakes is 10 miles below the surface.

In contemplating ways to compute an effective hypocentral distance from a site to some representative earthquake whose magnitude is determined from equation (3.4.12), the need for some means of averaging the hypocentral distances to individual earthquakes contained in the data base becomes apparent. Further consideration reveals that a simple arithmetic average is inappropriate because the seismicity of the site (and therefore the magnitude of a representative earthquake) is dominated by the stronger earthquakes recorded around the site. Simple averaging does not take into account the relative magnitudes of the earthquakes which have occurred, only their respective locations. Thus, for example, if the data base contained only two events over a time period L, a magnitude 8 earthquake directly under the site, (r = 10 miles) and a magnitude 6 earthquake 100 miles away (r = 100), the representative earthquake for the same period of time would have a magnitude of at most 8, and an effective hypocentral distance equal to 55 miles. Clearly, the ground motion resulting in this case will be considerably lower than that resulting from the magnitude 8 earthquake with its epicenter at the site, and therefore will underestimate the dynamic environment of the site.

An averaging method which uses magnitude in some form of weighting scheme would seem to be desirable. A second alternative considered involved the use of an energy equivalence involving particle velocities at basement rock due to the various earthquake events occurring in the vicinity of the site. This led to the equation

$$V^2 = \sum_i V_i^2 \qquad (3.4.14)$$

where V_i represents the particle velocity at basement rock due to the ith earthquake event some distance r_i away, and V represents the particle velocity of the representative earthquake at a distance r away. In order to use this equation, we must be able to determine V (or V_i) given M (or M_i) and r (or r_i). The velocity attenuation equation

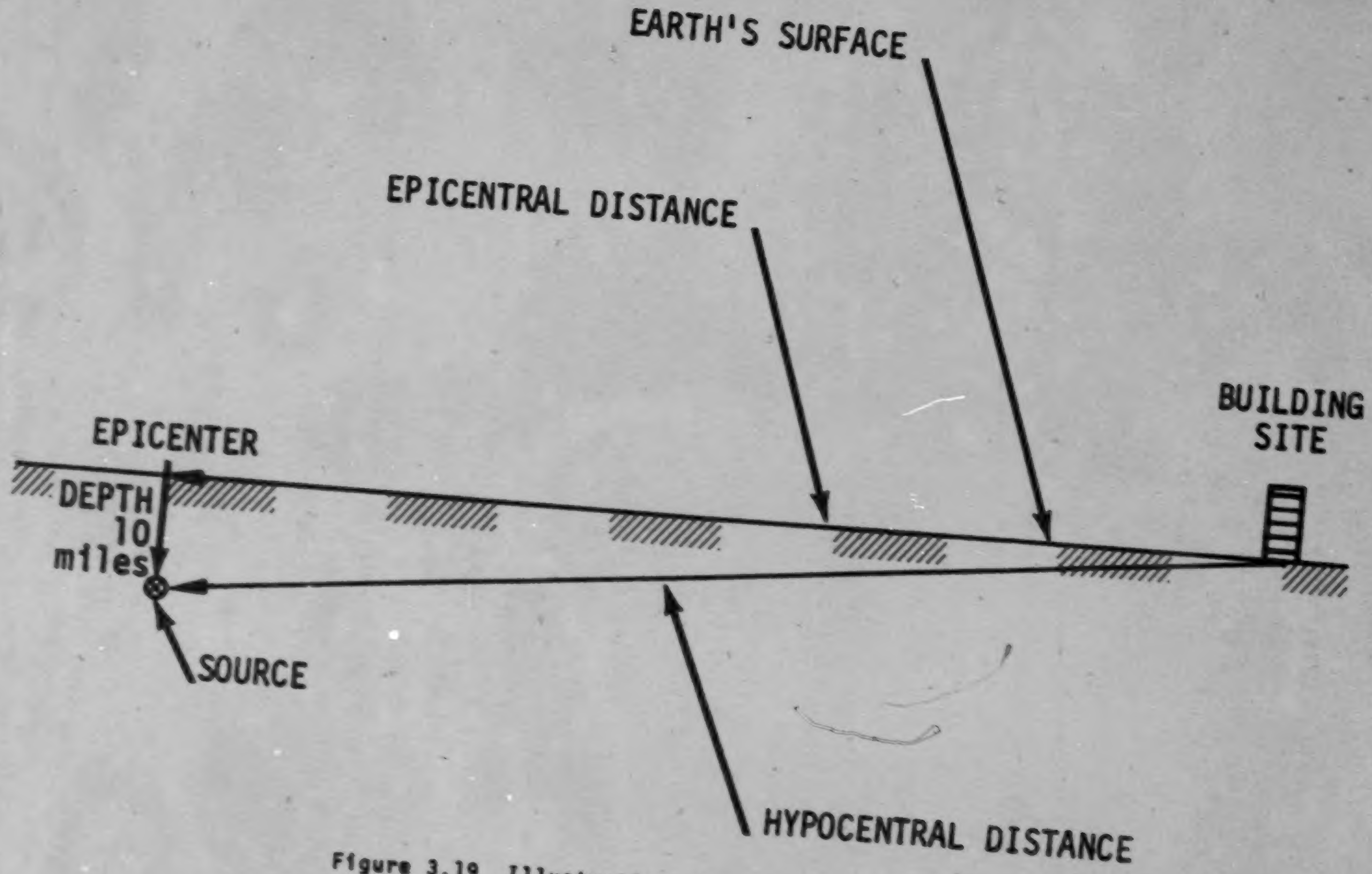

EARTH'S SURFACE
EPICENTRAL DISTANCE
BUILDING SITE
EPICENTER
DEPTH 10 miles
SOURCE
HYPOCENTRAL DISTANCE

Figure 3.19 Illustration of Hypocentral Distance

$$V = C_1\ 10^{C_2 M}\ r^{-C_3} \tag{3.4.15}$$

discussed in later paragraphs of this section is applicable here, the subscript on r and V being omitted for notational convenience. Thus, the attenuation relationship involving V_1, may be written

$$V_1 = C_1\ 10^{C_2 M_1}\ r_1^{-C_3} \tag{3.4.16}$$

Substitution of V and V_1 from equation (3.4.15) and equation (3.4.16) into equation (3.4.14) enables one to solve for r in terms of M, M_1 and r_1.

Although this approach has some appeal and tends to give reasonable values for r, the stipulation of an energy equivalence is somewhat arbitrary and in fact, turns out to be inconsistent with the basic seismicity equation (3.4.1). In Appendix J of [3.11] the derivation of an alternate equation which is used in place of equation (3.4.14) is derived and is

$$V^{b/C_2} = \sum_{1} V_1^{b/C_2} \tag{3.4.17}$$

It is seen to be similar in form to equation (3.4.14), but replaces the exponent 2 with the constant $b/C_2 = 1.60$ where $b = 0.9$ and $C_2 = 0.563$ as given in later paragraphs of this section.

Equation (3.4.14) suggests a possible interpretation for equation (3.4.17). Instead of interpreting equation (3.4.14) as an energy equivalence, we may take the point of view that V is given as well as each of the V_1's, and furthermore that all of the V_1's are equal. Then the upper limit n of the index 1 becomes the unknown variable in the equation

$$V^2 = \sum_{1=1}^{n} V_1^2 = n\ V_1^2 \tag{3.4.18}$$

Thus the equivalence factor is n which specifies how many earthquakes causing a site (basement rock) velocity V_1 are equivalent to one earthquake causing the velocity V. In the case of equation (3.4.14), for example, if the ratio $V/V_1 = 10$, then $n = 100$. In the case of equation (3.4.17) one sees that for the ratio $V/V_1 = 10$, $n = 10^{1.6} = 40$.

Therefore, forty earthquakes producing a hard-rock velocity of $V_1 = 1$ are equivalent (from the standpoint of seismicity) to one earthquake producing a hard-rock velocity of $V = 10$.

This relationship is even more apparent from the relationship (also derived in Appendix J of [3.11]).

$$\log_{10}N = \left[A + \frac{b}{C_2}\ \log_{10}C_1 - C_3\left(\log_{10}r\right)\right] - \frac{b}{C_2}\ \log_{10}V \qquad (3.4.19)$$

which comes about from substituting equation (3.4.15) into equation (3.4.1) to eliminate M. This equation when compared with equation (3.4.1) reveals the same linear form, treating the quantity in square brackets as a constant with a negative slope of b/C_2 instead of b which appears in equation (3.4.1). Thus it is evident that the quantity b/C_2 is just the slope of the $\log_{10}$ N versus $\log_{10}$ V histogram which could be developed directly from the data using equation (3.4.16).

Finally then, substituting for V and V_i from equation (3.4.15) and equation (3.4.16) into equation (3.4.19) gives the result

$$r = \left[\sum_i 10^{(M_i-M)}\ r_i^{\ -bC_3/C_2}\right]^{-C_2/bC_3} \qquad (3.4.20)$$

Equivalently, using equation (3.4.1) one concludes that

$$r = \left[\sum_i 10^{(A_i-A)}\ r_i^{\ -bC_3/C_2}\right]^{-C_2/bC_3} \qquad (3.14.21)$$

In actually computing r, an approximation was made to reduce computing time. Instead of treating each recorded earthquake individually where the index i ranges over the number of earthquakes within the radius of search, representative earthquakes of magnitude M_i were computed for each 1/2 x 1/2 degree grid area and located at the center of that area. The r_i's then represented the distance between the site and the center of each of these grid areas.

Generation of a Hard-Rock Velocity Spectrum

This section describes how a hard-rock velocity spectrum is developed from the Richter magnitude and hypocentral distance which are appropriate for the building site under consideration. The approach taken herein is parallel in concept to that proposed by Newmark and Rosenblueth [3.5] in that a hard-rock velocity spectrum is established from the maximum acceleration, velocity and displacement that is expected at the site. Figure 3.20 shows how a hard-rock spectrum is defined in terms of:

A_r = maximum hard rock acceleration (g)

V_r = maximum hard rock velocity (in/sec)

D_r = maximum hard rock displacement (in)

Therefore, in order to define a spectrum, a relationship must be established between the Richter magnitude (M) and hypocentral distance (r) and the maximum bedrock acceleration (A_r), velocity (V_r) and displacement (D_r). Such relationships are commonly referred to as attenuation relationships.

Donovan, see [1.4], has presented a survey of several attenuation relationships. The approach used herein is based upon the relationship between the site Modified Mercalli Intensity (MMI) and the site Richter magnitude and hypocentral distance, see equations (3.4.2) and (3.4.3). Also using El Centro and Ferndale earthquake data it can be shown [3.18] that the maximum soil particle velocity (V_s) can be expressed in terms of MMI using the following equation

$$\log_{10} V_s = -1.973 + 0.375\ \text{MMI} \qquad (3.4.22)$$

When taking into account the soil conditions at the El Centro and Ferndale sites it follows, see [3.20] and [3.21], that the hard-rock particle velocity, V_r, and the site Richter magnitude and hypocentral distance are related by the following equations.

Western United States (longitude $\geq$ 105°)

$$\log_{10} V_r = -1.625 + 0.563M - 1.403 \log_{10} r \qquad (3.4.23)$$

Eastern United States (longitude < 105°)

$$\log_{10} V_r = -2.062 + 0.563M - 0.979 \log_{10} r \qquad (3.4.24)$$

The cut-off longitude choice between the western and eastern regions of the United States is based upon:

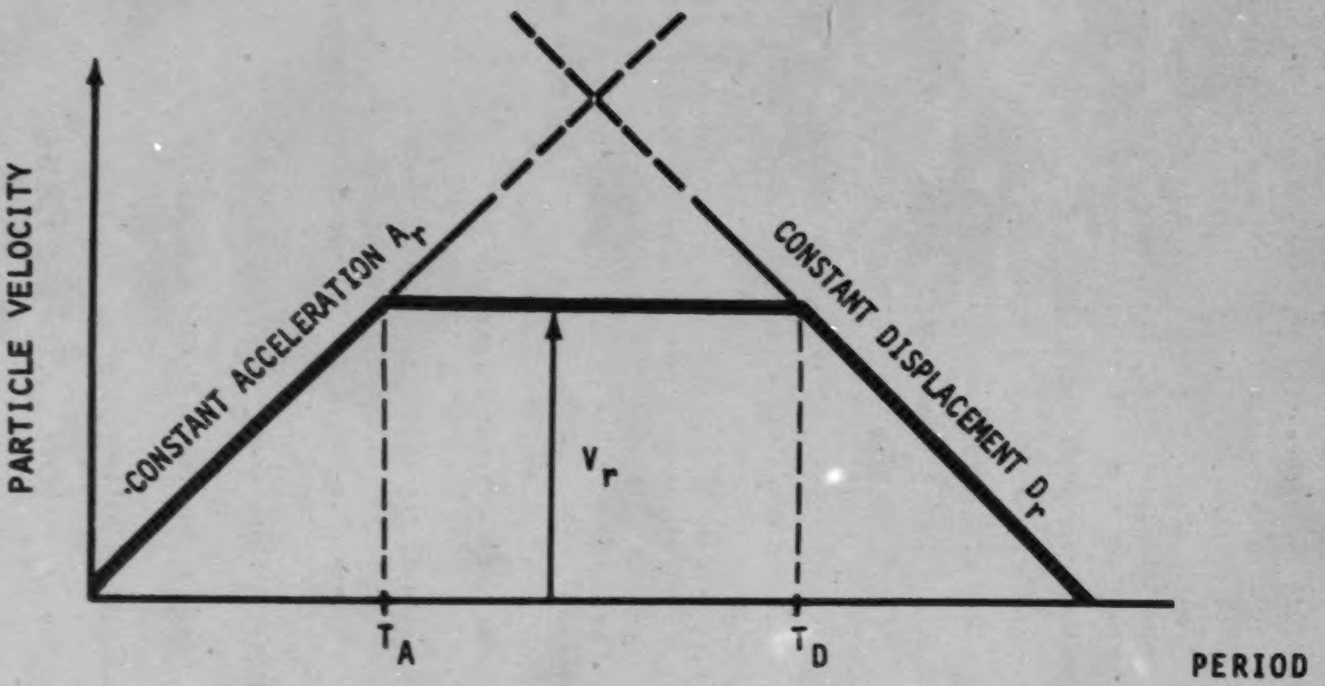


Figure 3.20 Hard Rock Velocity Spectrum on Tripartite Log-Log Plot

(1) the knowledge that the great plains regions ends at about 105° prior to encountering the Rocky Mountains [3.22],

(2) technical presentations by several seismologists at the May 1973 meeting of the Seismological Society of America.

Comparing the above attenuation equation with that derived by Nuttli [3.23] for the Central regions of the United States, one obtains -0.955 versus the value in equation (3.4.19) of -0.979. References [3.24 and 3.25] develop an attenuation relationship for particle velocity from underground nuclear explosive data in Nevada to be -1.39. This value agreed very well with the exponent -1.403.

Empirical evidence indicates that the maximum hard-rock acceleration and displacement are related to the maximum hard rock velocity. Figure 3.21 shows a plot of maximum hardrock acceleration and displacement versus velocity for the data in [3.18]. It is seen that the following relationships are appropriate:

$$\log_{10}A_r = -1.5675 + 0.7781 \log_{10}(V_r) \qquad (3.2.25)$$

$$\log_{10}D_r = -0.6144 + 1.1438 \log_{10}(V_r) \qquad (3.2.26)$$

Generation of Site Response Spectrum

The previous section discussed how a hard-rock velocity spectrum is established for a particular building site. This spectrum is amplified by the soil between the basement rock and the foundation of the building. In particular, expressing the site hard-rock velocity spectrum as a function of period using the notation

$V_{HR}(T)$ = site hard-rock velocity spectrum

then the site spectrum can be written as

$$V_{site}(T) = (DAF)_s \times V_{HR}(T) \qquad (3.4.27)$$

where

$(DAF)_s$ = soil dynamic amplification factor (in general also a function of period)

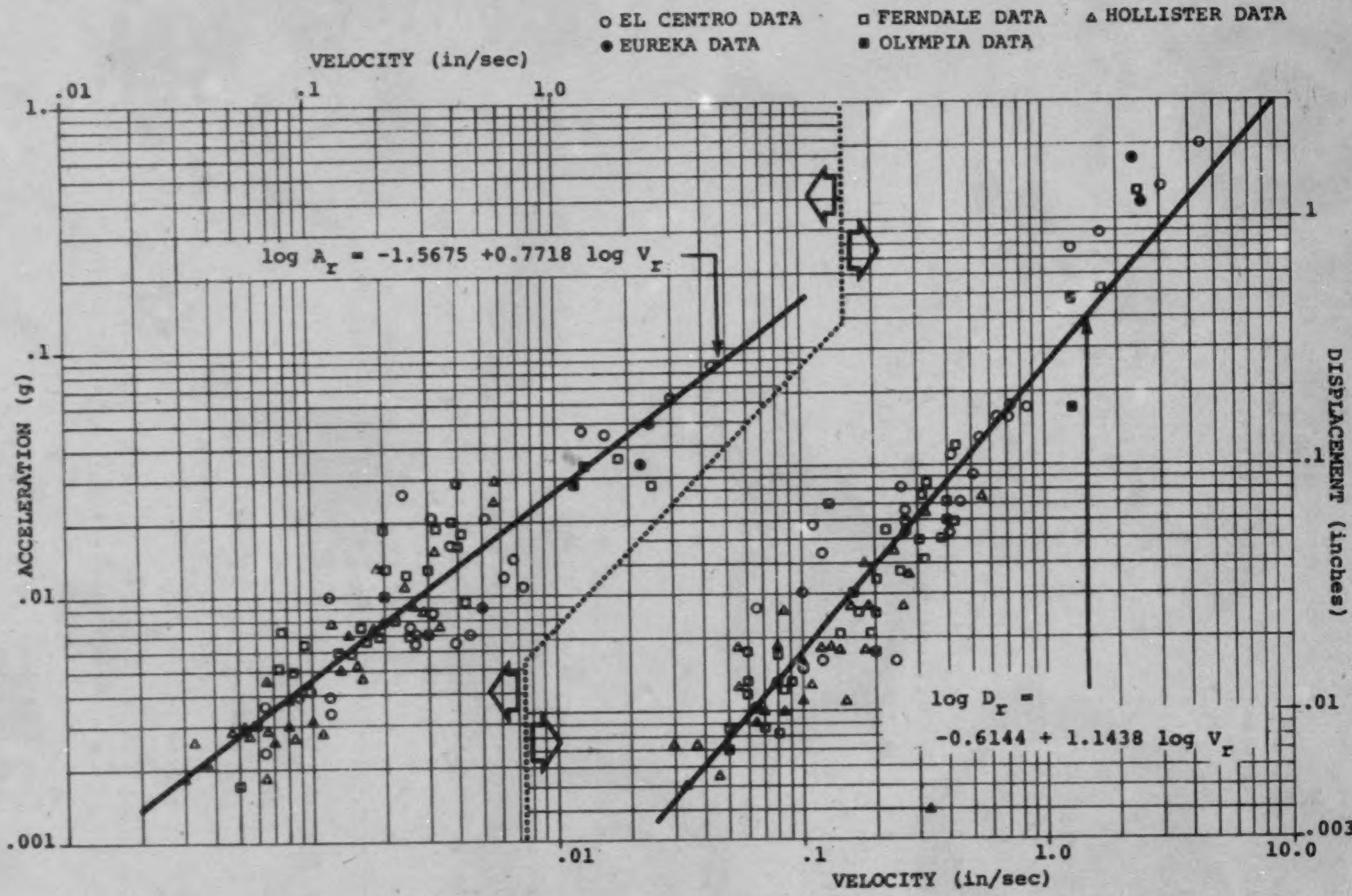


Figure 3.21 Acceleration Increases at a Lesser Rate Than Velocity Whereas Displacement Increases at a Greater Rate

The dynamic amplification factor of a site is a very difficult function to characterize. Opinions range from the idea that all sites give random characteristics, so it is impossible to model them, to the idea that all sites are very predictable in their dynamic behavior [3.24]. The computer program gives the user a number of options for computing this controversial property. The options are as follows.

Option No. 1: Complex

Reference [3.20] discusses a methodology employed for modeling the response of continuous, viscous damped, horizontally layered media to shear waves traveling vertically through the media. The theoretical development of this method is attributed to Sezawa and Kanai in 1931 and the soil respomse equation takes the form

$$\frac{\rho_n \partial^2 u_n}{\partial t^2} = \frac{\partial G_n}{\partial z} \quad \frac{\partial u_n}{\partial z} + G_h \; \frac{\partial^2 u_n}{\partial z^2} + \xi_n \left(\frac{\partial^3 u_n}{\partial z^2 \partial t} \right) \qquad (3.4.28)$$

where

G_n = shear modulus
u_n = displacement
ρ_n = density
Z = depth
h = layer number
t = time
ξ_n = damping factor

As noted in [3.20] this method is only valid for periods less than one second since surface waves, not shear waves, significantly influence the spectral magnitudes in the higher period regions. Also, if the soil layers extend to hard rock in deep sedimentary deposit areas, the amplification factors can significantly under estimate a site spectrum in both the low and high period regions.

Option No. 2: Semi-Complex

The second option is the same as No. 1 with the exception that each soil layer's shear wave velocity is calculated in the program using the results of conventional static soil properties as opposed to being measured in the field. The user must input for each layer:

(a) Damping of the layer (% of critical)
(b) Thickness (ft)
(c) Wet density (lb/cubic ft)
(d) Water content (% of dry density)

A discussion of the derivation of shear wave velocities from the above static soil parameters and a guide for the estimation of soil damping is presented in Appendix I of [3.11].

The remainder of the options presented herein calculate a soil amplification function which is independent of period. For this reason they are referred to as simple methods. The following options should only be applied when limited soil data are available.

Option No. 3: Simple Method (a)

Wiggins [3.20, 3.21] has developed the equation confirmed by Campbell and Duke [3.26],

$$(DAF)_s = \left(\frac{V_o \rho_o}{V_{SH} \rho_s}\right)^{0.5} \qquad (3.4.29)$$

ρ_s = average density of site soil (lb/ft^3)

ρ_o = density of basement rock (lb/ft^3)

V_{SH} = average shear wave velocity of the site soil (ft/sec)

V_o = shear wave velocity of basement rock (ft/sec)

Under this option the user estimates soil density, layer thickness, and water content. From this data an approximate shear wave velocity profile is calculated in the program and the average values are used in equation (3.4.29).

Option No. 4: Simple Method (b)

If available dynamic data do not enable the use of Simple Method (a), but the static data are adequate for deriving site shear wave velocities (either for one or multiple layers of soil) then this option is to be used. Also, it is noted that this option uses equation (3.4.29).

Option No. 5: Simple Method (c)

Medvedev [3.27] has proposed an approach for calculating the site amplification which is essentially independent of period. His equation is given by

$$(DAF)_s = \left[\frac{V_o}{V_p}\right]^{.503} \times 10^{.301 e^{-.0037h^2}} \qquad (3.4.30)$$

where

V_o = P-Wave velocity of granite (basement rock) (ft/sec)

V_p = P-Wave velocity of site (ft/sec)

h = Depth to water table, (ft)

For various site characteristics, Medvedev [3.27] gives values for V_p, see table 3.8.

Table 3.8 MEDVEDEV'S VELOCITIES FOR P-WAVE [3.27]

Material	V_p (ft/sec)
Granite (basement rock)	18,383
Limestone and sandstone	10,856
Gypsum and marl	7,024
Rock debris and gravel	4,423
Sandy and clayey ground	3,618
Fill or soft soil	1,194

The values for h must be determined or estimated by the user in addition to the specification of the material under the site.

Option No. 6: Simple Method (d)

Reference [3.20] has suggested a method for computing the $(DAF)_s$ using equation (3.4.29) and knowing only the geologic description of the material to compute V_{SH}. The equation is

$$V_{SH} = 41.8\ (ZT)^{1/6} \tag{3.4.31}$$

where

Z = depth of deposit

T = age of deposit in years

Table 3.9 gives the ages of the materials that are specified to be located under the user's site [3.20].

Table 3.9 MATERIAL AGE VERSUS PERIOD

Era	Period	Age (x 10^6 years)
Cenozoic	Holocene	0.011
	Pleistocene	1.
	Quaternary	2.5
	Pliocene	16.
	Miocene	26.
	Oligocene	35.
	Eocene	43.
Mesozoic	Cretaceous	93.
	Jurassic	152.
	Triassic	175.
Paleozoic	Permian	192.
	Pennsylvanian	220.
	Mississippian	245.
	Devonian	284.
	Silurian	355.
	Ordovician	390.
	Canadian	415.
	Ozarkian	440.
	Upper Middle Cambrian	490.
	Lower Cambrian	515

C. Natural Hazard Loading - Wind

General Comments

The "fastest mile" wind speed is used as input to the wind load generation program. Caution must be exercised so as not to use published wind speeds based on averaging techniques that significantly differ from the "fastest-mile" wind speed determination since gust factors to be discussed in this section are dependent on the type of velocity data used to characterize the structural loading. Thus, the determination of a gust factor based on wind data from one averaging technique will not constantly describe random fluctuation about a mean wind velocity based on a fastest-mile averaging scheme.

Selection of Site Wind Speeds at 30 Feet Elevation

As the result of extensive work by Thom [3.28, 3.29, 3.30] using daily fastest-mile wind speed data from 141 open-country stations, extreme value statistics and instrument correction factors, annual extreme mile wind speeds for 2, 10, 25, 50 and 100 year mean return periods at various locations in the United States have been calculated. These data are presented in a form commonly referred to as Thom's maps. Figures 3.22 to 3.26 present the most recent of Thom's maps available at the time of this writing. The mean wind velocities are given only for a height 30 feet above ground. Table 3.10 presents Thom's wind data for Hawaii [3.30].

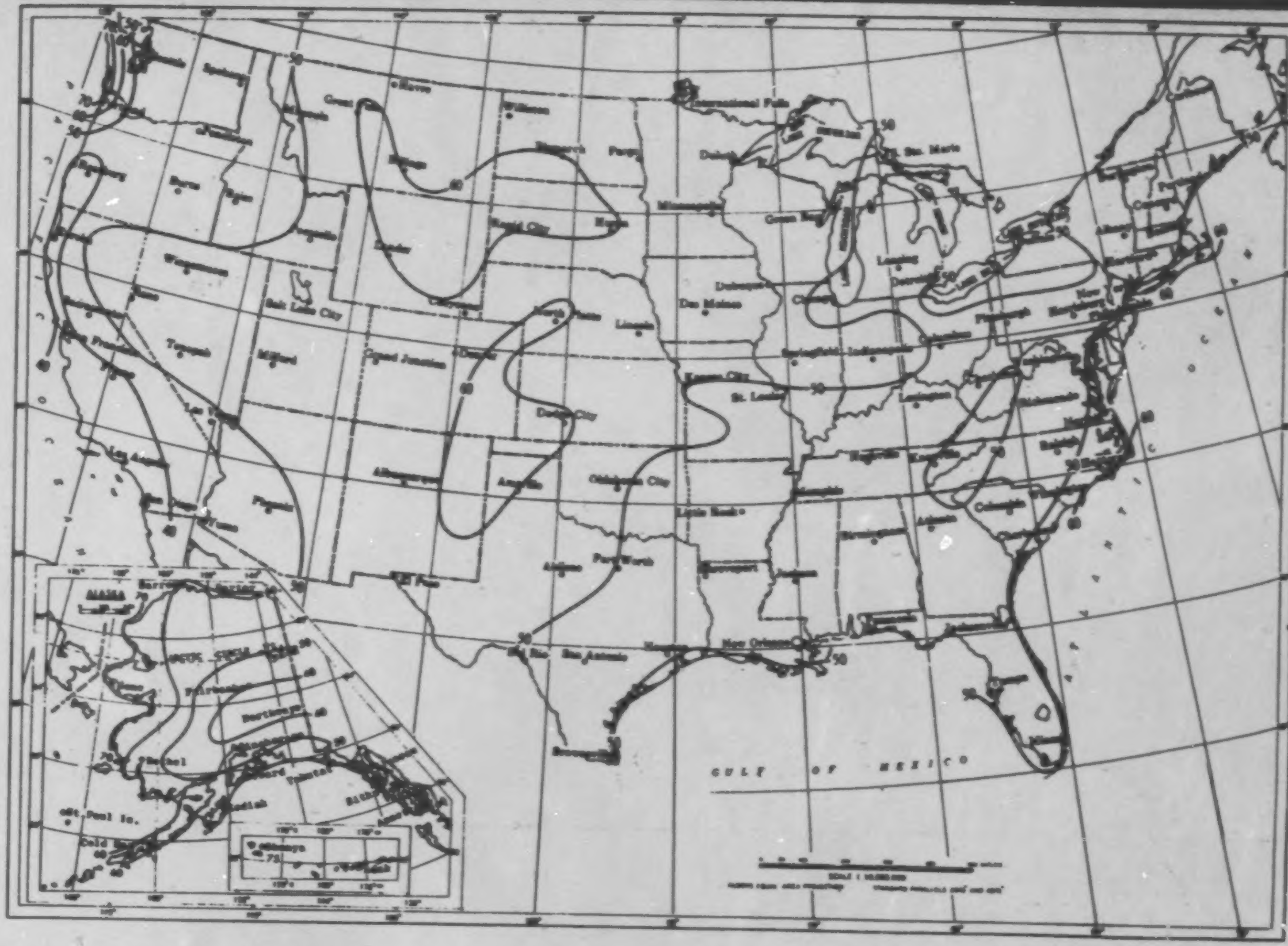
Although the physics of wind loading is indeed time dependent, at the present time demands of practicality preclude a dynamic approach. Instead, an equivalent static approach that uses a mean pressure distribution and gust factors is employed. The governing equation for the static approach is,

$$p = (1/2)\, C_p C_g \rho V_h^2 \left(\frac{H}{h}\right)^{2\alpha} \qquad (3.4.32)$$

where:

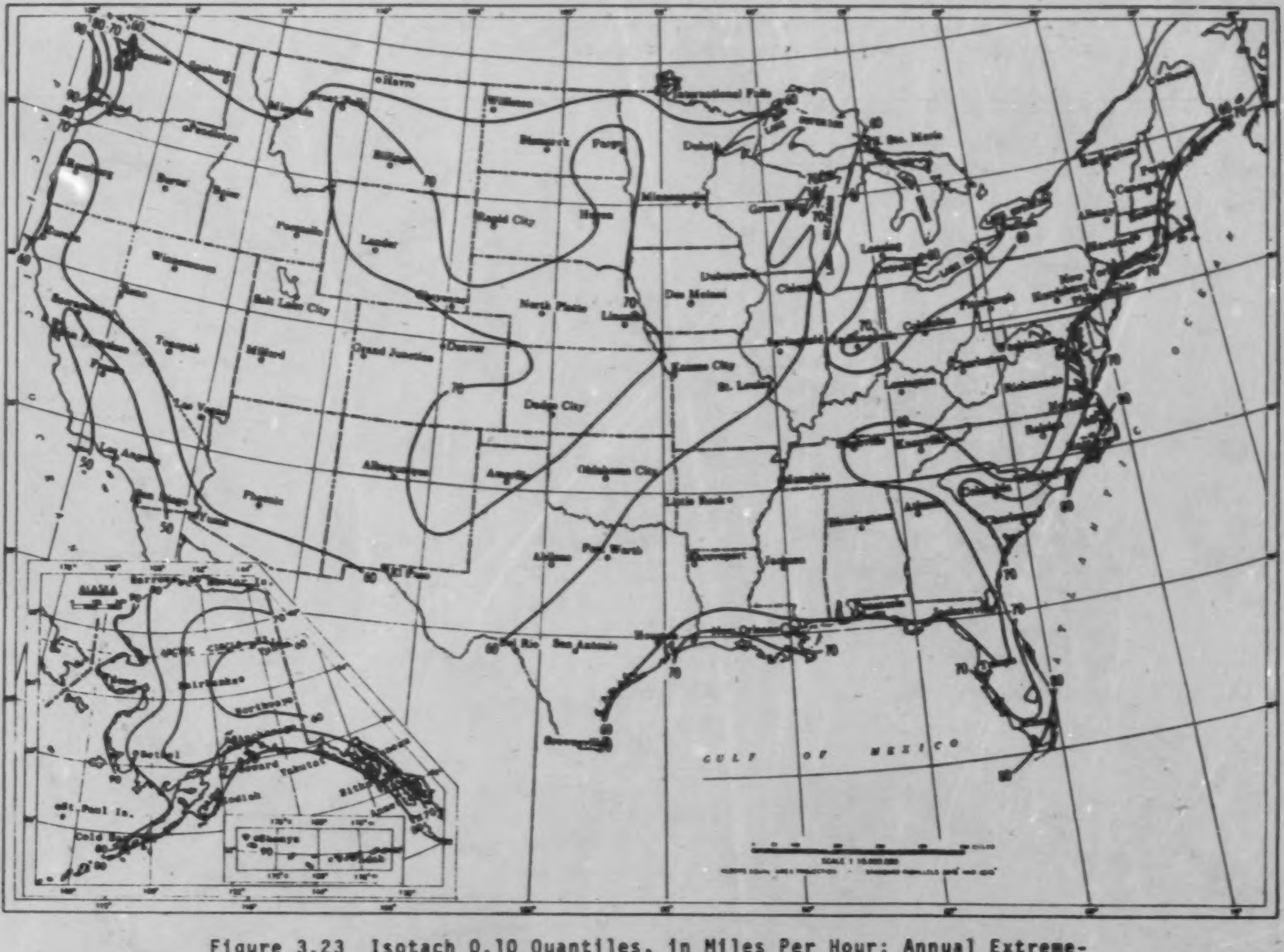
p = Equivalent static pressure intensity at height H (psf)

V_h = Fastest-mile wind velocity at 30 feet from Thom's maps (mph)



International Falls
Salt Lake City
Grand Junction
Rapid City
Des Moines
Kansas City
St. Louis
Springfield
Indianapolis
Dodge City
Oklahoma City
Little Rock
Fort Worth
San Antonio
Del Rio
New Orleans
Shreveport
El Paso
Los Angeles
San Diego
GULF OF MEXICO
ALASKA
Barrow
Fairbanks
Bethel
St. Paul Is.
Cold Bay
50
60
70
40

Figure 3.22 Isotach 0.50 Quantiles, in Miles Per Hour: Annual Extreme-Mile 30 Ft Above Ground, 2-Yr Mean Return Period [3.30]


Havre
Williston
International Falls
Bismarck
Fargo
Duluth
Sault Ste. Marie
Billings
Rapid City
Huron
Minneapolis
Green Bay
Lander
Cheyenne
North Platte
Lincoln
Des Moines
Dubuque
Chicago
Salt Lake City
Grand Junction
Denver
Kansas City
St. Louis
Dodge City
Albuquerque
Amarillo
Oklahoma City
Little Rock
Abilene
Fort Worth
Shreveport
El Paso
Del Rio
San Antonio
Brownsville
Las Vegas
Los Angeles
San Diego
Yuma
Phoenix
Tonopah
Milford
Winnemucca
Boise
Pocatello
Pendleton
San Francisco
GULF OF MEXICO
ALASKA
Barrow
Barter Is.
ARCTIC CIRCLE
Fairbanks
Northway
Bethel
Kodiak
Yakutat
Sitka
Annette
St. Paul Is.
Cold Bay
Shemya
50
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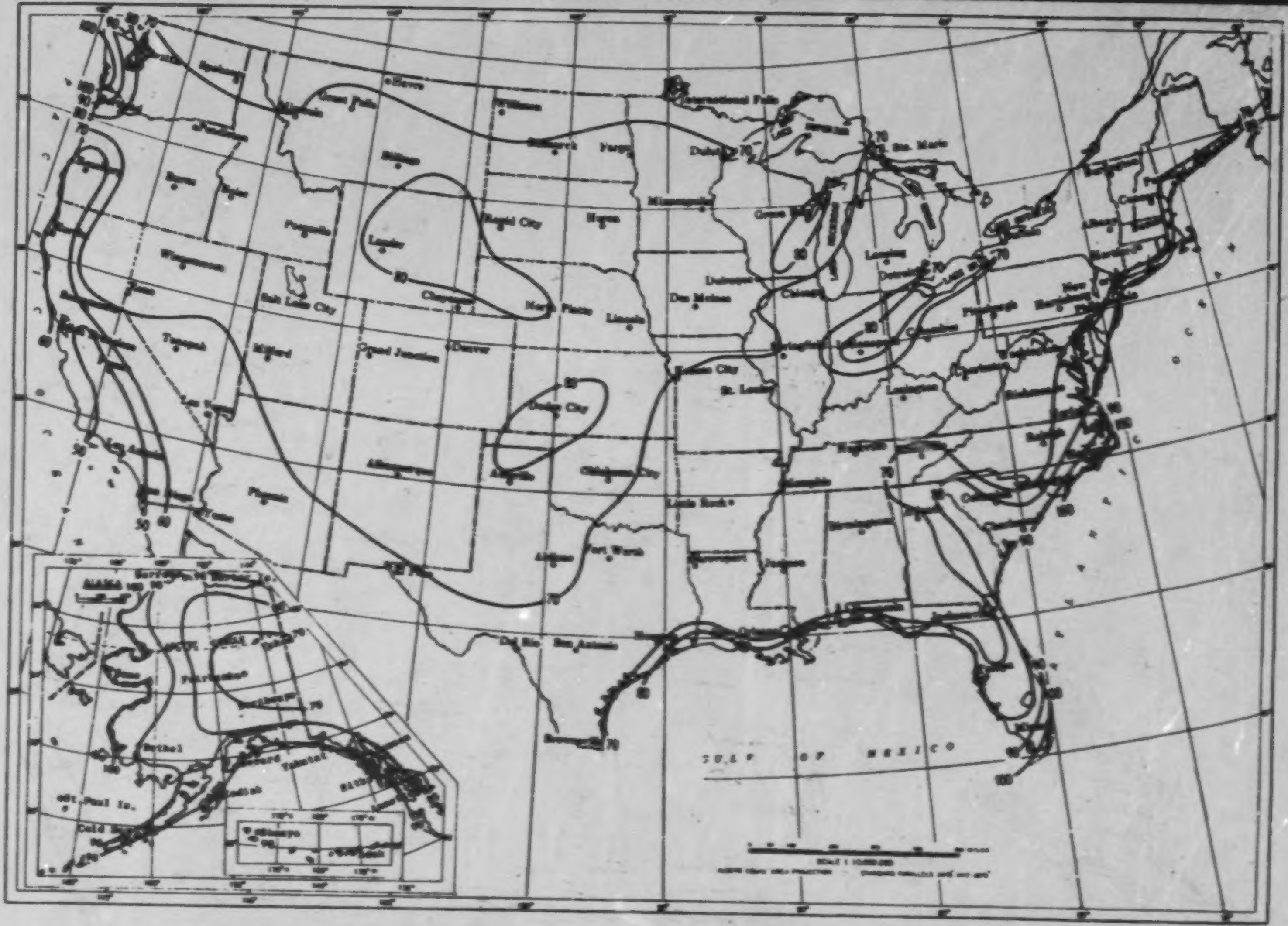
SCALE 1:10,000,000

Figure 3.23 Isotach 0.10 Quantiles, in Miles Per Hour: Annual Extreme-Mile 30 Ft Above Ground, 10-Yr Mean Return Period [3.30]


GULF OF MEXICO
ALASKA
St. Paul Is.
Cold Bay
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Fairbanks
International Falls
Duluth
Sault Ste. Marie
Minneapolis
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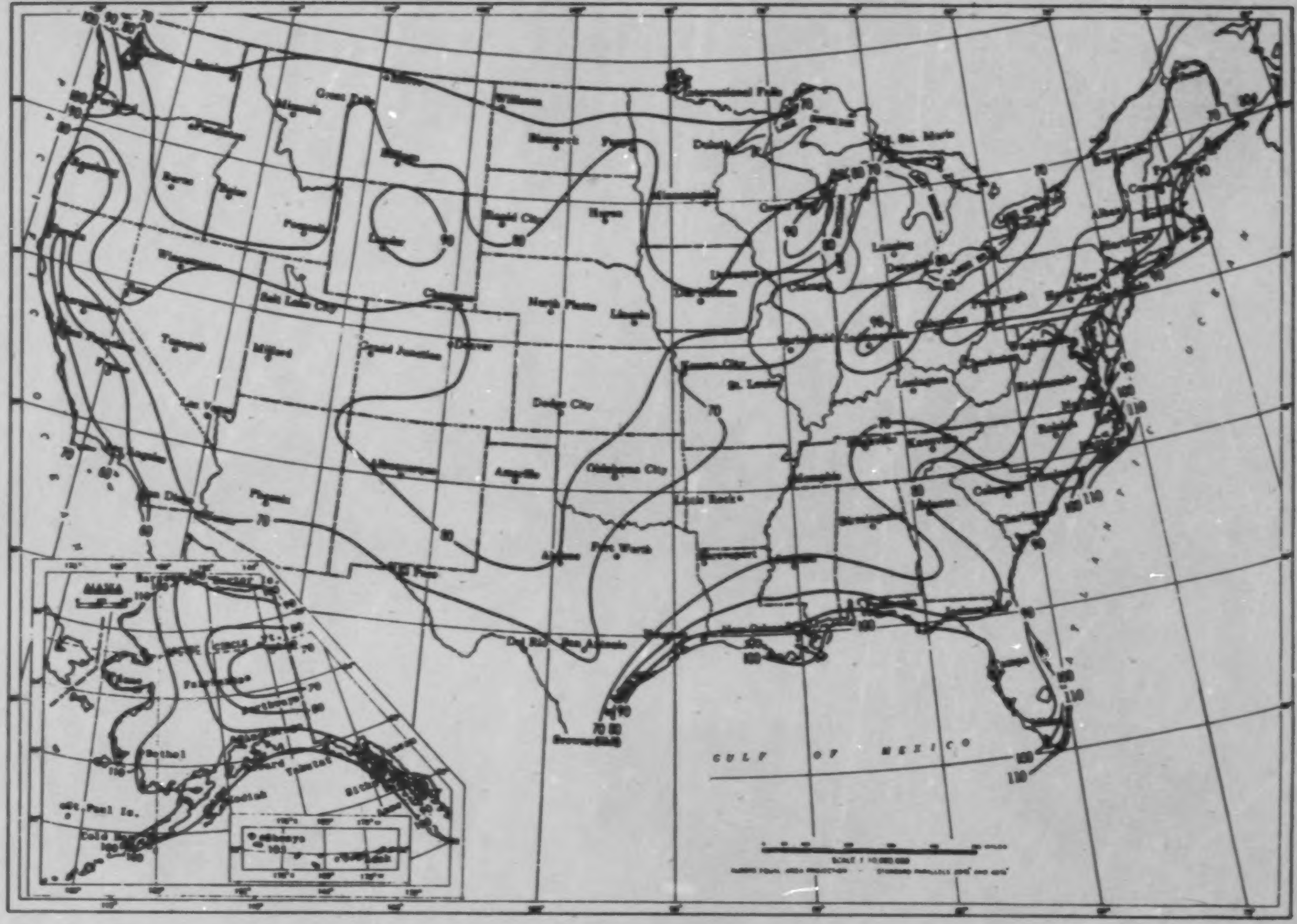
Fargo
Billings
Great Falls
Missoula
Spokane
Pendleton
Boise
Pocatello
Winnemucca
Salt Lake City
Lander
Cheyenne
Rapid City
North Platte
Lincoln
Des Moines
Dubuque
Green Bay
Kansas City
St. Louis
Grand Junction
Denver
Milford
Tonopah
Las Vegas
Los Angeles
San Diego
Yuma
Phoenix
Albuquerque
El Paso
Dodge City
Amarillo
Oklahoma City
Abilene
Fort Worth
Little Rock
Shreveport
Del Rio
San Antonio
Brownsville
50
60
70
80
90
100

Figure 3.24 Isotach 0.04 Quantiles, in Miles Per Hour: Annual Extreme-Mile 30 Ft Above Ground, 25-Yr Mean Return Period [3.30]


International Falls
Great Falls
Williston
Bismarck
Fargo
Duluth
Sault Ste. Marie
Huron
Rapid City
Salt Lake City
Milford
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Las Vegas
Phoenix
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Grand Junction
North Platte
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Kansas City
St. Louis
Dodge City
Amarillo
Oklahoma City
Little Rock
Fort Worth
Abilene
Del Rio
San Antonio
Shreveport
Lansing
Columbia
Raleigh
Charleston
Richmond
ALASKA
Barter Is.
Fairbanks
Bethel
Anchorage
Kodiak
Yakutat
Sitka
St. Paul Is.
Cold Bay
G U L F   O F   M E X I C O
70
80
90
100
110

Figure 3.25 Isotach 0.02 Quantiles, in Miles Per Hour: Annual Extreme-Mile 30 Ft Above Ground, 50-Yr Mean Return Period [3.30]

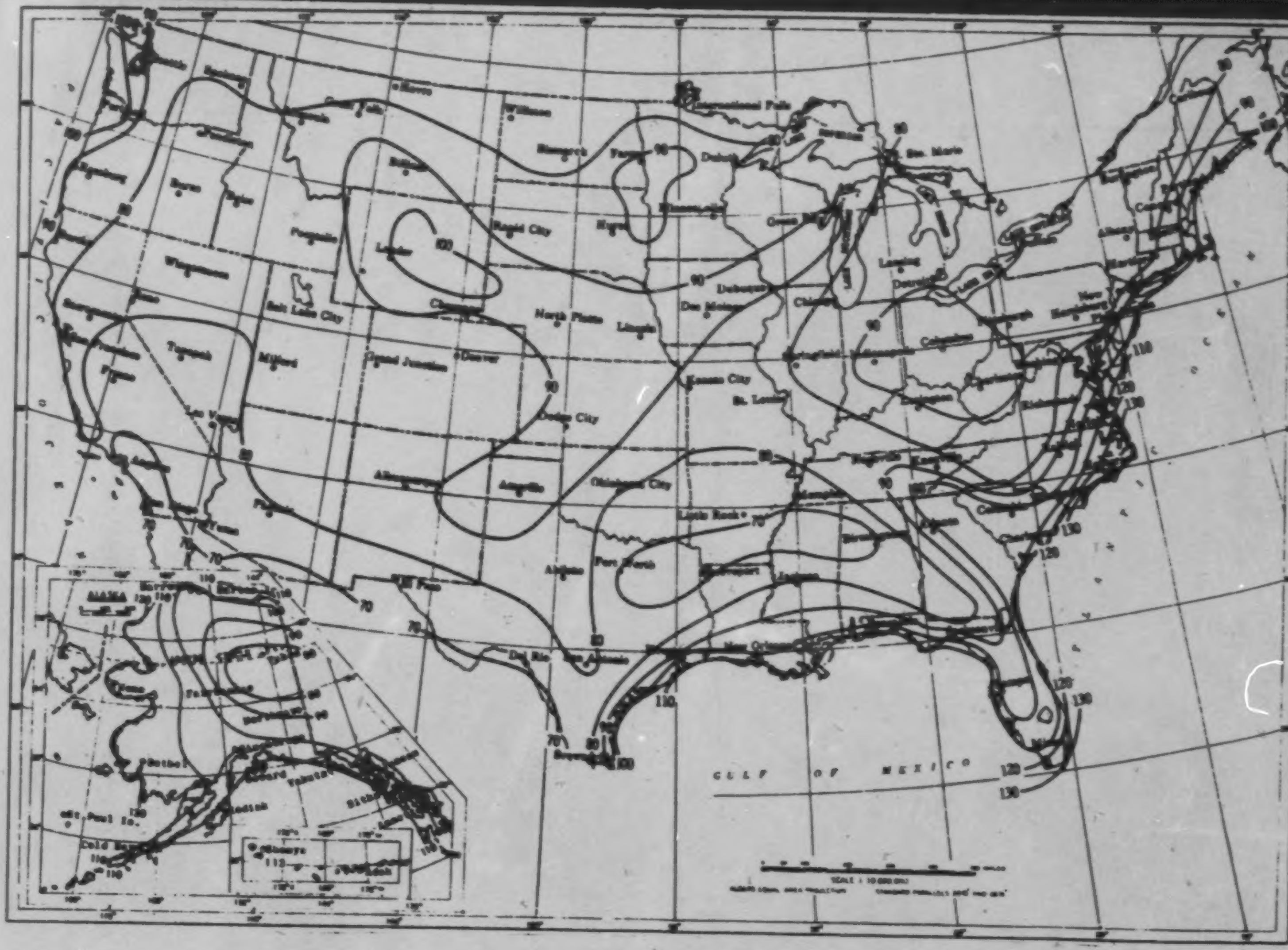

GULF OF MEXICO
ALASKA
Salt Lake City
Rapid City
North Platte
Lincoln
Grand Junction
Denver
Dodge City
Amarillo
Oklahoma City
Kansas City
St. Louis
Little Rock
Fort Worth
Abilene
El Paso
Del Rio
San Antonio
Milford
Tonopah
Las Vegas
Lander
Cheyenne
Sault Ste. Marie
International Falls
Des Moines
Dubuque
Chicago
Columbus
Lansing
New Orleans
St. Paul Is.
Cold Bay
70
80
90
100
110
120
130

Figure 3.26 Isotach 0.01 Quantiles, in Miles Per Hour: Annual Extreme-Mile 30 Ft Above Ground, 100-Yr Mean Return Period [3.30]

H = height above ground (ft)

h = 30 feet

ρ = air density (at 15°C, 760 mm of mercury)

α = surface roughness coefficient

C_p = shape factor

C_g = gust factor at height H

Table 3.10 HAWAII FASTEST MILE DATA (mph) AT SEA LEVEL*[3.30]

	Return Period (years)				
	2	10	25	50	100
Leeward Exposure	38	51	60	67	75 mph
Windward Exposure	42	59	70	80	91 mph

*The following comment applies only to Hawaii. Since the data of table 3.10 is taken at sea level stations it must be converted to an equivalent fastest mile wind velocity at 30 feet above the ground for a site at an elevation Z feet above sea level. The user must do the following conversion before entering the data into the wind program:

$$V_{Z30} = V_{30}\left(\frac{Z + 30}{30}\right)^{1/7}$$

where

V_{30} = a velocity from table 3.10 (mph)

Z = elevation of site above sea level (ft)

V_{Z30} = new fastest mile wind velocity at 30 feet above ground for the site (mph)

Equation (3.4.32) applies to either a statistical or single-valued analysis of wind loading. The statistical analysis is done using Thom's maps for all return periods. For example, at some arbitrary site we find that Thom's maps yield the following information:

Return Period (years) (1/N)	N	Velocity (mph)
2 (figure 3.22)	0.50	V_1
10 (figure 3.23)	0.10	V_2
25 (figure 3.24)	0.04	V_3
50 (figure 3.25)	0.02	V_4
100 (figure 3.26)	0.01	V_5

Where N is defined as the number of times per year a wind with a speed greater than or equal to V_i ($i = 1$ to 5) occurs.

Plotting the above data for the hypothetical site on a semilog scale (see figure 3.27) allows the regression equation

$$\log_{10} (N) = C_1 - C_2 V_h \qquad (3.4.33)$$

to be fitted to the data. The coefficients C_1 and C_2 are site dependent constant coefficients determined by a least squares linear fit of data of the type given in figure 3.27. Note the similarity between (3.4.1) and (3.4.33).

Equation (3.4.32) may also be used for a single value analysis of wind loading. This may be accomplished by using one value of V_h and solving directly for p, independent of the statistical approach. It is noted that V_h need not be derived from Thom's maps. The user may select a wind speed which is based upon a detailed local velocity study. Regardless of the source, V_h must be the "fastest-mile" wind velocity at 30 feet above the ground.

Site Wind Speeds at Various Elevations

Thom's maps only give the basic wind velocity at 30 feet above the ground. Therefore, a relationship must be obtained in order to find the distribution of velocity with height. The most important factor affecting the shape of the wind velocity variation with height is surface roughness.

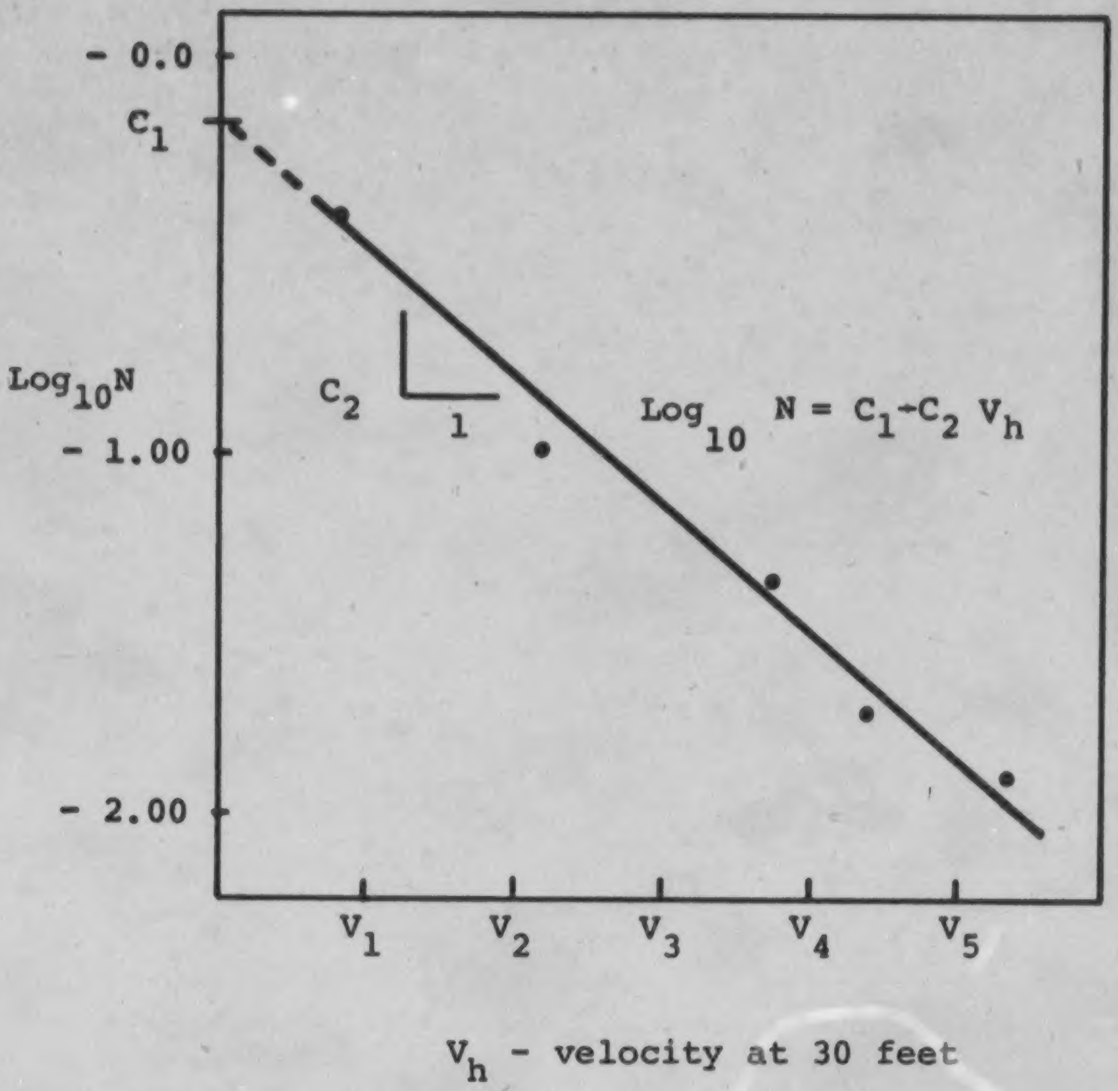


Figure 3.27 Regression Analysis of Wind Data From Thom's Maps for a Hypothetical Site

Surface roughness is the cumulative drag effect of buildings, trees, rocks, vegetation, etc., on the wind flow. Surface roughness does not include effects of local shielding of near-by objects. The variations of wind flow due to near-by ridges and valleys, etc., are also not included in the effects of surface roughness. Surface roughness is a minimum over the ocean and a maximum in a large city. Based upon the principles of fluid mechanics the mean velocity profile for turbulent flow at relatively low Reynolds numbers is described by,

$$V_H = V_o \left(\frac{H}{h}\right)^{\alpha} \qquad (3.4.34)$$

If the reference velocity is taken at 30 feet, it then follows that equation (3.4.34) becomes

$$V_H = V_{30}\left(\frac{H}{30}\right)^{\alpha} \qquad (3.4.35)$$

The exponent α incorporates the influence of surface roughness. Based on studies by Davenport [3.31, 3.32], as interpreted by Vellozzi and Cohen [3.33], the suggested exponents are given in table 3.11.

Table 3.11 POWER LAW EXPONENTS FOR VARIOUS TERRAINS

Description of the Terrain	Power Law Exponent (α)	Gradient Height (Z_g ft)
For open country, flat coastal belts, small islands situated in large bodies of water, prairie grassland, tundra, etc.	1/7	900
For wooden countryside, parkland, towns, outskirts of large cities, rough coastal belts	1/4.5	1200
For centers of large cities	1/3	1500

In table 3.11 Z_g is the height to the gradient velocity V_g, (the point above ground where the velocity distribution becomes uniform).

Gust Factors

The gust factor coefficient is used to describe the effects of random fluctuation of wind pressure about the mean wind pressure. The term "gust factor" is a relative one. A 10 second average wind is a gust on a 1-minute average wind while a 1-minute average wind is a gust on a 1-hour average wind. Thus, a measure other than duration should be used for a consistant evaluation of gust factors.

The method for the formulation of gust factors (C_g) in the wind load generation program is based on the work of Vellozzi and Cohen [3.33]. Several formulations of the gust factor C_g result in a single numerical value for a building [3.2, 3.32], however, the approach of Vellozzi and Cohen yields a gust factor which is a function of height and is also a function of the dynamic characteristics of the building and its surroundings. The details of the Vellozzi and Cohen gust factor formulation which is the method used in this procedure are given in [3.33].

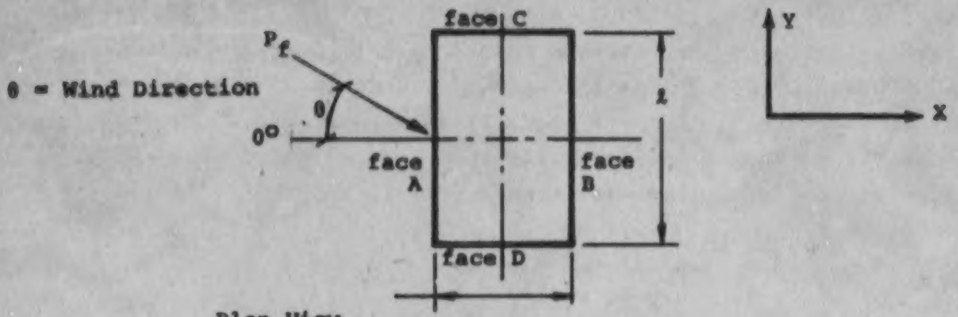
It has been emphasized that Thom's maps refer to a wind velocity in terms of fastest-mile wind. Vellozzi and Cohen's gust factor formulation, however, is in terms of a mean hourly wind velocity. The conversion of a fastest-mile wind velocity to a mean hourly wind velocity, is accomplished using a formula proposed by Vellozzi and Cohen [3.33]. Reference [3.33] uses gust factors for fastest-mile and mean hourly wind speeds and concludes that both sets of gust factors result in the same loading on the building. Thus, although gust factor formulation is dependent on type of wind data used, the quantity of interest - the loading - is essentially the same for both approaches.

A limitation of the gust factor formulation is that it applies to situations where the principal wind loading is drag. Other loadings induced by Von Karman Vortex shedding and by vortices shed from other structures are beyond its scope. Instability of the galloping and flutter types is also not included [3.32].

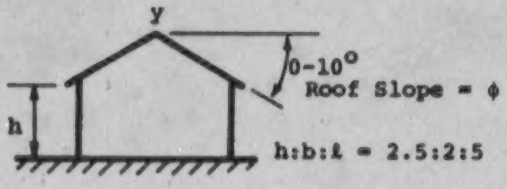
Shape Factors

The shape of a building in the wind stream greatly affects the distribution of wind pressure over the structure. The shape factor coefficients are designed to take into account the effects of the building's configuration on the wind stream flowing over, around, and through the structure.

The term "shape factor" is somewhat misleading in that it is not one number unique to one particular building. Instead it is made up of a series of pressure coefficients which, in turn, depend on the building's size and orientation in the wind stream. For example, figure 3.28 shows the pressure coefficients for a typical building and how these pressure coefficients go into calculating the shape factor in each building direction.


θ = Wind Direction
P_f
θ
0°
face C
face A
face B
face D
ℓ
Y
X

Plan View


y
0-10°
Roof Slope = φ
h
h:b:ℓ = 2.5:2:5

Elevation View

Pressure Coefficients on Faces A,B,C,D

	Faces			
θ	A	B	C	D
0	.9	-.5	-.7	-.7
45	.5	-.5	.4	-.3
90	-.3	-.3	.9	-.3

(+) → Direct Pressure into face

(-) → Suction Away from face

Building Shape Factors

$(C_p)^x$ = (pressure coefficient on face A)-(pressure coefficient on face B)

= shape factor in x-direction

$(C_p)^y$ = (pressure coefficient on face C)-(pressure coefficient on face D)

= shape factor in Y-direction

Figure 3.28 Shape Factors and External Pressure Coefficients [3.35]

In 1958 the ASCE Committee on Wind Forces [3.34] presented its findings on wind forces on enclosed structures. Data from the ASCE, Swiss Building Code, [3.35], Danish Building Code and the University of Iowa were presented and discussed. Admittedly, the Swiss data based on wind tunnel tests were the best to that date in the ASCE's Review. As recently as 1968, McGuire [3.36] notes that the Swiss data is the most comprehensive for general use.

Since the Swiss data most efficiently describes the distribution of wind pressure and includes the effect of wind direction on the external loading, it is the procedure used herein for determining "Shape Factor Coefficients" in the wind load program. More study in this area is certainly needed, especially for turbulent flow on building structures.

Table 3.12 shows a sample of the structures that are included in the computer program for the calculation of "Shape Factors." A complete list of all structures is given in the Users Manual, see Appendix E. Note that the Swiss data are for specific building dimension ratios. In order to accommodate the user who may not wish to use the Swiss data, two additional options are provided from the ANSI Standards [3.2] for the calculation of "Shape Factors Coefficients." Thus, if the building under study does not satisfy the Swiss dimensional requirements, one may use the ANSI shape factors. If the user chooses, he may by-pass the shape factor available in the computer and input his own selected values for the shape factors.

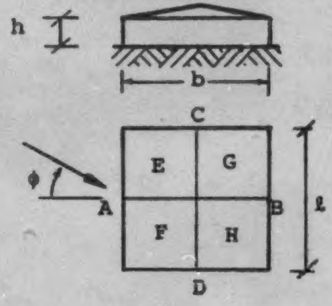
Internal Pressures

In addition to pressure loading on the exterior of the building, the wind stream flowing around the building causes changes in the internal pressure of the building depending on the amount and location of openings, i.e., windows, vents, etc. Figure 3.29 shows a typical set of internal pressure coefficients. Although internal pressures are present, their effect on the frame action of the building for all practical purposes is zero since the assumed uniformity of the change in internal pressure cancels in the specification of lateral frame loadings. Internal pressure coefficients are important in the design or analysis of individual walls, roofs and other local features.

Table 3.12 Building Identification by Code I Type Using Swiss [3.35] External Pressure Coefficients

ITYPE = Building Shape Code

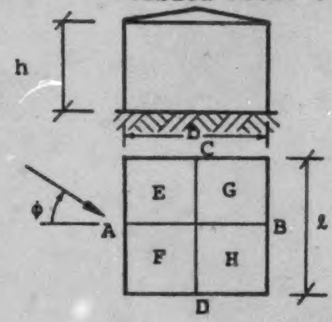
1 **Gabled Roofs 0°-3°**


h
b
C
E
G
F
H
ϕ
A
B
ℓ
D

h:b:ℓ = 1:4:4

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.4	-.4	-.8	-.8	-.3	-.3
45°	.5	-.4	.5	-.4	-.9	-.6	-.6	-.3
90°	-.4	-.4	.9	-.3	-.8	-.3	-.8	-.3

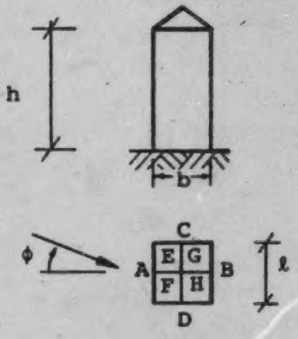
2 **Gabled Roofs 0°-10°**


h
b
C
E
G
F
H
ϕ
A
B
ℓ
D

h:b:ℓ = 1:1:1

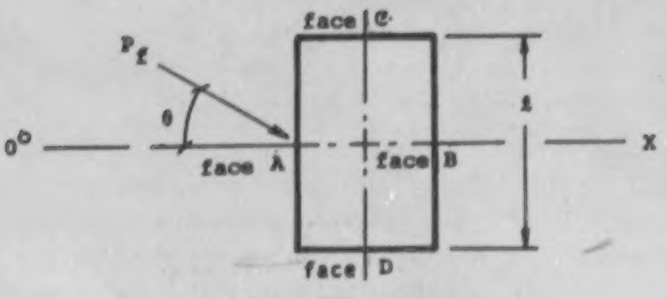
ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	-.7	-.7	-.5	-.5
45°	.5	-.5	.5	-.5	-.8	-.5	-.5	-.4
90°	-.6	-.6	.9	-.5	-.7	-.5	-.7	-.5

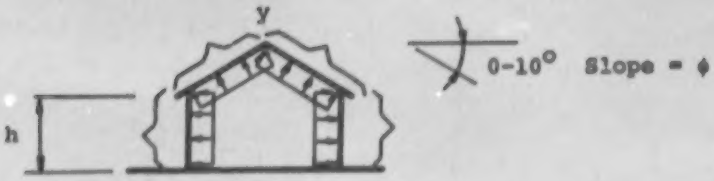
3 **Gabled Roofs 0°-15°**


h
b
C
E
G
F
H
ϕ
A
B
ℓ
D

h:b:ℓ = 2.5:1:1

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.6	-.7	-.7	-.8	-.8	-.8	-.8
45°	.5	-.5	-.5	-.5	-.8	-.7	-.7	-.5
90°	-.7	-.7	.9	-.6	-.8	-.8	-.8	-.8


face
C
P_f
θ
0°
face A
face B
ℓ
X
face D


y
h
0-10° Slope = φ

Only Internal Pressure Shown

Internal Pressure Coefficients

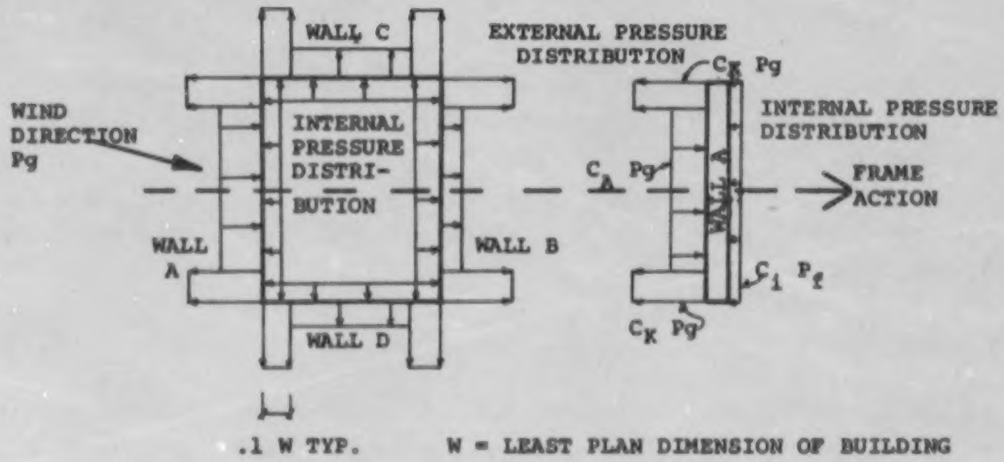
θ	Mainly Side A	Mainly Side B	Mainly Side C
0°	+.8	-.4	-.6
45°	+.5	-.4	+.3
90°	-.4	-.4	+.8

Figure 3.29 Internal Pressure Coefficients

The wind pressures calculated using equation (3.4.32) with a prescribed shape factor C_p are only appropriate for calculating gross frame response. This limitation is due to the neglecting of local wind pressure rises and internal pressure coefficients. When considering gross frame response the latter cancels and the former is assumed to be averaged out over the spacial extent of the structure.

The estimation of window damage caused by wind pressure is a function of the direction of the wind, exposure, external pressures and gust factors, and internal pressures. While frame response considers only wind loading along the line of action of the two-dimensional planar model, the estimation of window damage is based on wind pressures on all exterior walls of the building in a three-dimensional sense. To accomplish this, the external pressure distribution with height for each wall (windward, leeward and sides) is specified by use of the external pressure coefficients. Next, a determination of the internal pressure (or suction) coefficient is specified in terms of two parameters: the wall with the majority of the window area (windward, wall, leeward wall, side wall(s) or a uniform distribution) and a ratio of the open area to solid area of the wall with the majority of the openings. Internal pressures are assumed to be uniform on all interior surfaces at a given height. Note that while external pressures incorporate the effects of gusting, internal pressures do not, due to damping provided by restricted exterior openings.

Having now specified a distribution of external and internal pressures, the net pressure loading on the windows is determined for each wall. In addition, changes in local pressures at the corners of the buildings are considered. This analysis yields a net pressure distribution with height for pressure loading on windows adjacent to the corners within a region of one-tenth the least building dimensions. Thus, five net pressure distributions are determined for the three-dimensional analysis of window damage: four for the walls and one for the corners, see figure 3.30. The formulation of internal pressure calculations is consistent with ANSI A58.1-1972 recommendations [3.2].


WALL C
EXTERNAL PRESSURE DISTRIBUTION
C_K Pg
WIND DIRECTION Pg
INTERNAL PRESSURE DISTRIBUTION
WALL A
WALL B
WALL D
INTERNAL PRESSURE DISTRIBUTION
C_A Pg
WALL A
FRAME ACTION
C_i P_f
C_K Pg
.1 W TYP.
W = LEAST PLAN DIMENSION OF BUILDING

PLAN VIEW
OF i^{TH} FLOOR
(a)

FREE BODY
OF WALL A
IN PLAN
(b)

FREE BODY ANALYSIS OF WALL A (SEE b ABOVE)

CORNERS

$$-(C_K)\ Pg - (C_i)\ P_f = P_1$$

WALLS

$$(C_A)\ Pg - (C_i)\ P_f = P_2$$

where:

C_A = External pressure coefficient Wall A (Figure 3.28)

C_K = External pressure coefficient for building corners [3.35]

C_i = Internal pressure coefficient [3.35]

Pg = Pressure at i^{th} floor level approaching building with gust factor included

P_f = Pressure at i^{th} floor level approaching building without gust factor

P_1 = net pressure acting at the corners for window damage calculations

P_2 = net pressure acting on wall for window damage calculations

Figure 3.30 Specification of Net Pressure for Window Damage Calculations

D. Natural Hazard Loading - Tornado and Hurricane

General

The extent to which a building is damaged due to tornado or hurricane loads is a function of the user's specification of the wind velocity. The procedure utilized herein requires the user to specify the wind speed for a tornado or hurricane but presents guidelines to assist in the decisional process.

Tornado - General Comments

The Atomic Energy Commission has debated what the maximum tornado wind velocity is for a number of years and has arrived at an extreme velocity estimate of about 325 mph for computational purposes. Other estimates of tornado wind velocities range from 100 to 500 mph [3.37].

The design of buildings to resistant tornado forces and the accompanying problem of damage evaluation is perhaps the most complex problem discussed in this report. At the time of the writing of this report considerable research effort is being expended in the tornado risk area. Therefore, the procedure presented herein represents a first step. Prior to presenting the approach used herein, a few general comments about the current topics under study seems appropriate. First, the classification of tornadoes as to wind velocity, pressure drop and other intensity parameters is felt to be very important. At the present time only Thom [3.38] has presented a statistical analysis of tornado occurrence and his data does not distinguish between small and large tornadoes. The data only reflects the occurrence of a tornado. Serious attention is being directed at this intensity factor and it appears that one scale (called the FPP scale) will be adopted by NOAA. Second, the correlation between the numerical values of tornado parameter values must be more carefully studied before confident damage predictions can be made. For example, a statistical analysis must be made of parameter values such as rotational wind speed and pressure drop for a set translational tornado velocity. Certainly a correlation exists and it must have a significant statistical scatter which must be taken into account. Third, missle motion during a tornado needs and is receiving careful attention. Damage due to flying debris (often the debris is an automobile or a water tank!) is considerable and only after this topic has received considerably more study can such items as window damage be confidently predicted. The questions are many but research is progressing at an accelerated pace. This section discusses an approach which is state-of-the practice and by using it good general damage estimates can be obtained.

The recommended procedure for selecting a tornado wind speed for use in the detailed damage evaluation procedure involves the use of statistical studies conducted by Thom [3.38]. In particular, using historical data, Thom discusses the probability of a tornado hitting a particular building located within a 1° by 1° grid. This probability of hit is a function of grid area, tornado return period for the site and the tornadoes path area. Therefore, the user may for his particular building site evaluate the probability of the occurrence of a tornado during a structure's life or any time span he wishes and also by selecting the width of the tornado path establish what the maximum tornado wind velocity will be.

The user evaluates the wind pressure loading on a building due to a direct tornado hit by using the same loading program as discussed in section 3.4.C.

Tornadoes are usually accompanied by severe pressure drops at their centers which cause buildings to explode as well as deform, if entirely closed. The internal pressure models in the wind loading program would underestimate this effect for a direct hit since the internal pressures from the tornado would change as more and more windows failed. In the Detailed Analytical Evaluation Method, only external pressure effects from tornado winds are considered. The user should recognize this limitation when evaluating tornado damage results using this loading model. It is believed that to include the pressure drop factor would be inappropriate due to the present uncertainty in the assigned values of the tornado parameters. Similarly, post tornado damage inspections have not established this as the primary cause of damage.

An evaluation of the damage to a building that does not suffer a direct hit is presented with certain limitations. To accomplish such an analysis the user would use the general wind loading program discussed in section 3.4.C. For this analysis the user must specify a value of tornado wind velocity (this should be less than the wind velocity of a direct hit), assume a site exposure and make use of both internal and external pressure coefficients. This wind model approach suggested for the "fringe" areas is based on the design example in [3.37] for wind velocity only, and from information presented in [3.39] which presented a gradient velocity distribution with building height to describe window damage to the Great Plains Life Building, Lubbock, Texas.

Tornado - Probability of Being Hit by A Tornado

The selection of a tornado wind velocity should start by using the assumption of a Poisson process and evaluating the probability of non-occurrence of an event (in this case, not being hit by a tornado) using

$$p = e^{-LN} \qquad (3.4.36)$$

where:

p = probability of not being hit by a tornado

L = lifetime of the building (years)

N = number of tornados per year hitting the site

(1/N) = return period of tornado

It then follows that the probability of a structure being hit by a tornado is given by,

$$P_0 = 1 - e^{-LN} \qquad (3.4.37)$$

The parameter N is a function of the tornado statistics and is specified as [3.38]

$$N = \frac{\overline{z}}{A} f \qquad (3.4.38)$$

where:

$\overline{z}$ = mean path area of the tornado, square miles

f = annual number of tornados per grid

A = area of the grid wherein the site is located, square miles.

Using a normal distribution for tornado path data from Iowa and Kansas tornados, Thom assigns a mean path area of 2.82 square miles. The area of the 1° grids of figure 3.31 is a function of latitude and longitude and may be found from geographical tables. For convenience, table 3.13 may be used to determine the grid area. Linear interpolation is suggested between values.

Table 3.13 AREAS OF 1° GRIDS (SQUARE MILES)

	Latitude of Middle of Grid					
	25°30'	30°30'	35°30'	40°30'	45°30'	50°30'
Area (square miles)	4300	4109	3887	3634	3354	2983

Substitution of equation (3.4.38) into equation (3.4.37) yields

$$P_o = 1 - e^{-2.82\ (Lf/A)} \qquad (3.4.39)$$

as the probability of a site being hit by a tornado.

The following are examples of how the tornado probabilities are computed:

Example 1 - Site A

Site: 41°N latitude

99°W longitude

$f = 1.7$ tornadoes per year (figure 3.31)

$A = 3634 - \left(\frac{0.5°}{5°}\right)(3634-3345) = 3606\ \text{mi}^2$ (table 3.13)

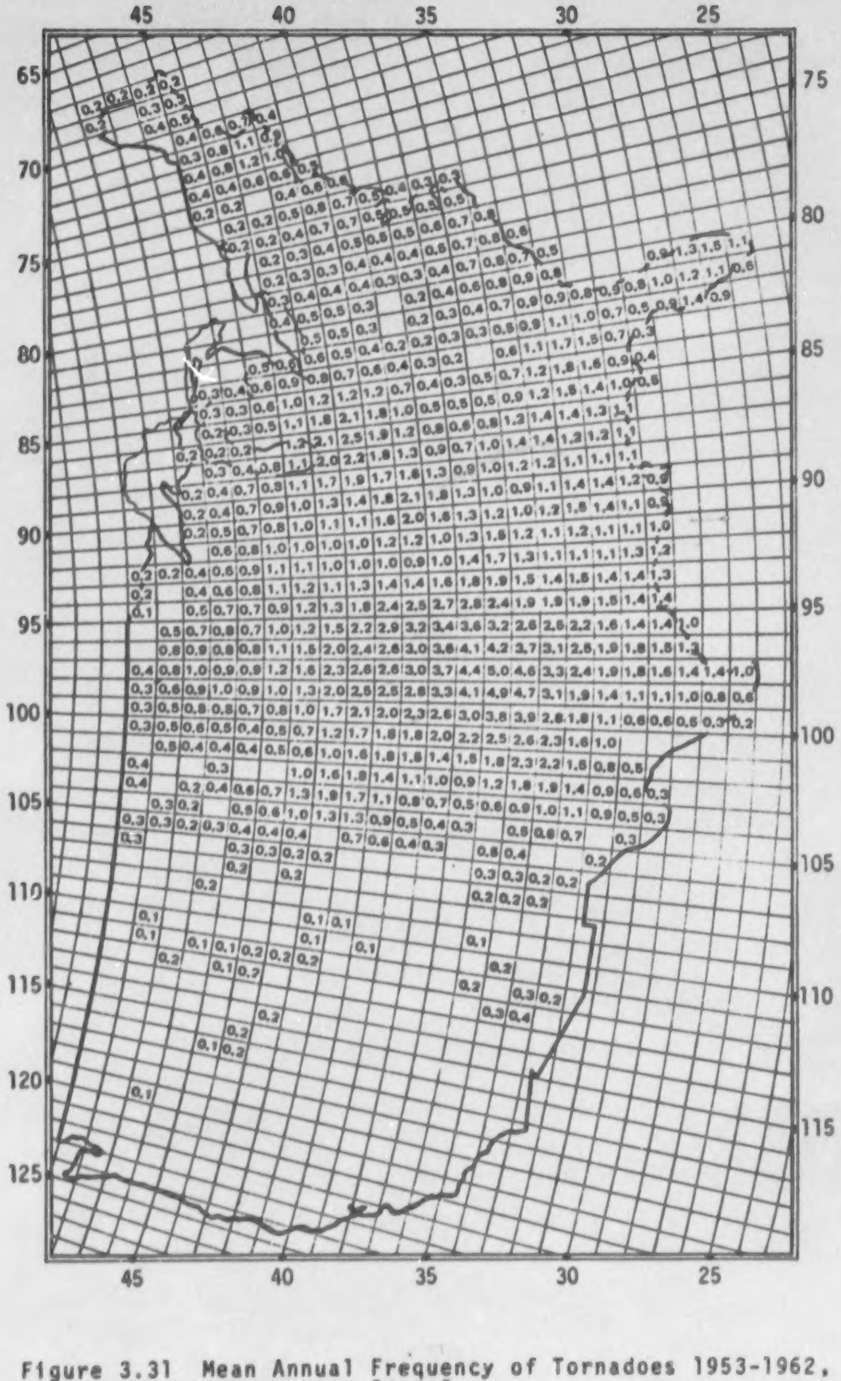


Figure 3.31 Mean Annual Frequency of Tornadoes 1953-1962, Parameter f [3.38]

L, Structure Life (yrs)	P_o, Probability of Site Being Hit by Tornado (%)
10	1.32
20	2.62
50	6.43
100	12.45

Example 2- Site B

Site: 30°30'N latitude
80°30'W longitude

f = 0.6 tornados per year (figure 3.31)

A = 3887 mi sq (table 3.13)

L, Structure Life (yrs)	P_o, Probability of Site Being Hit by Tornado (%)
10	0.43
20	0.87
50	2.15
100	4.26

Tornado - Selection of a Tornadoes Wind Velocity

Thom [3.38] has presented tornado occurrence frequency as a normal distribution and the area felt by a single tornado as log normal. Thus,

$$z_n = \left(\frac{1}{1760}\right) e^{\overline{v} + n\,\sigma_v} \qquad (3.4.40)$$

where:

z_n = path area (square miles)

$\overline{v}$ = 8.51 = natural logarithm of the mean path area, [3.38]

σ_v = 2.057 = standard deviation of $\overline{v}$, [3.38]

n = number of standard deviations

The Thom data extends only to an $n = \pm 2.0$, thus, the maximum felt area observed is 172.6 mi^2 and the minimum felt area is 0.046 mi^2. The velocity of tornado can be computed as a function of the area covered. The engineering judgment that area and velocity are correlated stems from the idea that a large area of coverage implies a well-developed and stable tornado. A small area implies that the tornado is partially developed and somewhat unstable. That is, of course not true in all cases. However, the assumption is reasonable and allows one to compute a velocity knowing the path area.

Equating 200 mph velocity with the lowest level of tornado area observation and 325 mph with the greatest area observation, it is desired to find the coefficients C_o and C_1 which satisfy the following simultaneous equations:

$$\text{Velocity} = C_o\ (\text{tornado area})^{C_1}$$

or

$$\left.\begin{aligned} 200 &= C_o(0.046)^{C_1} \\ 325 &= C_o(172.6)^{C_1} \end{aligned}\right\} = \begin{aligned} C_o &= 240 \text{ miles per hour} \\ C_1 &= 0.059 \end{aligned}$$

Thus, it follows that the estimated tornado velocity as a function of the path area is:

$$V(T)_n = \text{Tornado wind velocity in mph}$$

$$V(T)_n = 240 \left(\frac{e^{\bar{v}} + n\ \sigma_v}{1760} \right)^{.059} = 2.40\ (Z_n)^{0.059} \qquad (3.4.41)$$

where $+ 2 \leq n \leq -2$

It follows that corresponding to equation (3.4.38) one obtains

$$N = \frac{Z_n f}{A} \qquad (3.4.42)$$

$$(1/N) = \text{return period} = (A/Z_n f)$$

Example 1 - Site A

$n = 1,0,+1$ (user selected)

for $n=+1$, $Z_n = 22.1\ \text{mi}^2$, $(1/N) = 100$ yrs, $V(T)_n = 288$ mph
$n=0$, $Z_n = 2.82\ \text{mi}^2$, $(1/N) = 750$ yrs, $V(T)_n = 255$ mph
$n=-1$, $Z_n = 0.36\ \text{mi}^2$, $(1/N) - 5{,}900$ yrs, $V(T)_n = 225$ mph

Example 2 - Site B

$n = -1,\ 0,\ +1$ (user selected)

for $n=+1$, $Z_n = 22.1\ \text{mi}^2$, $(1/N) = 290$ yrs, $V(T)_n = 288$ mph
$n=0$, $Z_n = 2.82\ \text{mi}^2$, $(1/N) = 2{,}300$ yrs, $V(T)_n = 255$ mph
$n=-1$, $Z_n = 0.36\ \text{mi}^2$, $(1/N) = 17{,}850$ yrs, $V(T)_n = 225$ mph

Hurricane Occurrence and Selection of Wind Velocity

Friedman [3.40] has recently developed statistics for hurricane occurrence and velocities similar to Thom's approach to tornado and wind. The maps thus prepared are produced in figures 3.32 to 3.35.

The user must first establish whether he is going to analyze the structure for a minimal, major or extreme hurricane. As shown in figure 3.32 this decision is directly related to the wind velocity. The figures present the number of times in the past 100 years that the noted sites experienced the various levels of hurricanes. If this number of times is denoted f_o then the hurricane return period is $(f_o/100)$ years. It is also assumed that unlike the tornado, the hurricane envelops the entire grid and therefore there is no area based reduction in the data given in figure 3.32.

In using figures 3.32 to 3.35, the tornado probability-of-occurrence methodology outlined earlier can be used; however, equation (3.4.37) becomes

$$P_o = 1 - e^{-\frac{L f_o}{100}} \qquad (3.4.43)$$

As an example, consider the New Orleans area. It follows from figure 3.32 that

Return period (75 mph $\leq V(H) \leq$ 100 mph) = 12.5 years
Return period (101 mph $\leq V(H) \leq$ 135 mph) = 25 years
Return period ($V(H) >$ 135 mph) = 25 years.

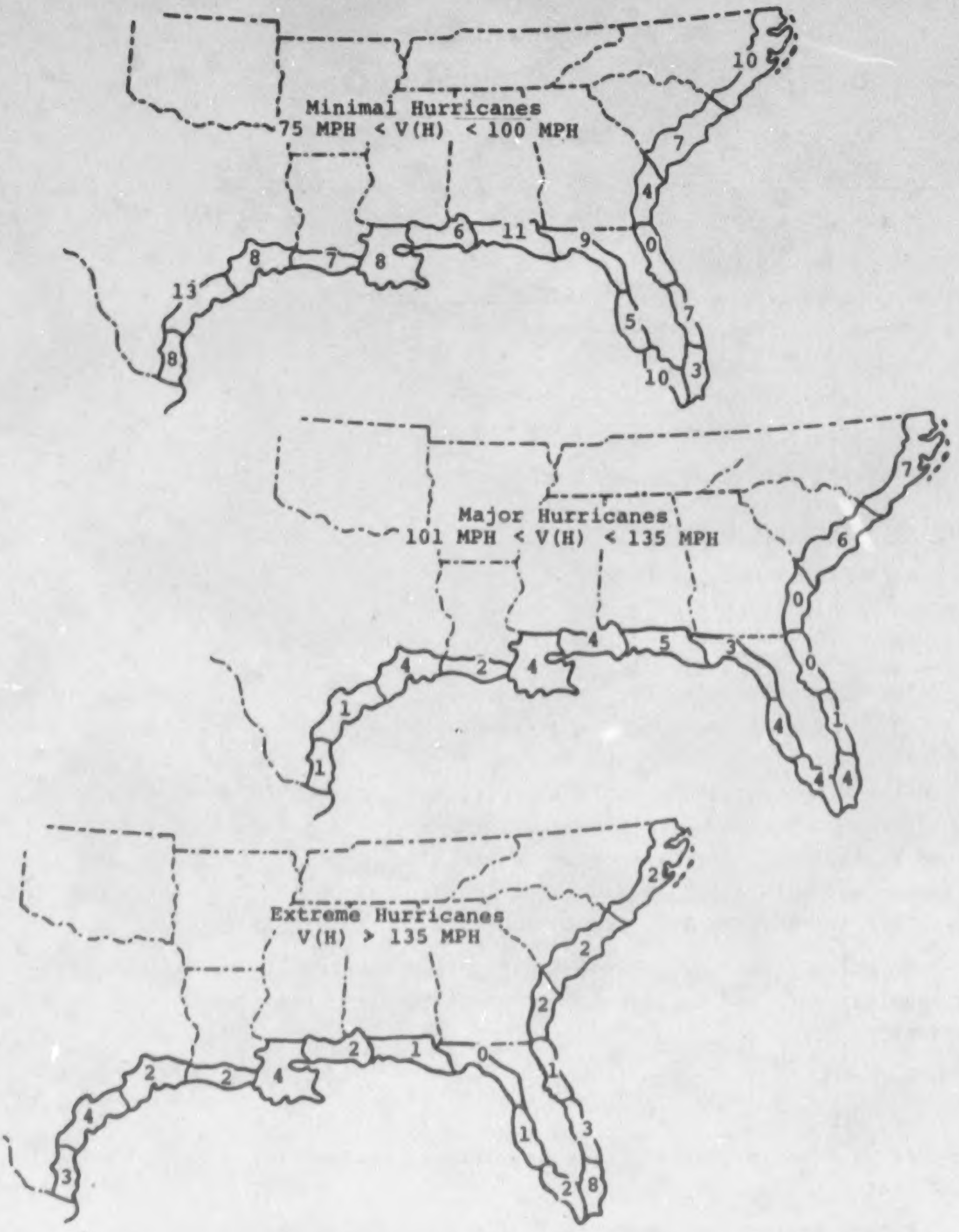

Minimal Hurricanes
75 MPH < V(H) < 100 MPH
10
7
4
6
11
9
0
8
7
8
13
8
5
7
10
3
Major Hurricanes
101 MPH < V(H) < 135 MPH
7
6
0
4
5
3
0
4
2
4
1
1
4
1
4
4
Extreme Hurricanes
V(H) > 135 MPH
2
2
2
2
1
0
1
2
2
4
2
4
3
1
3
2
8

Figure 3.32 Number of Times in the Past 100 Years That Segments of the Coastline Were Affected By Minimal, Major and Extreme Hurricanes [3.40]

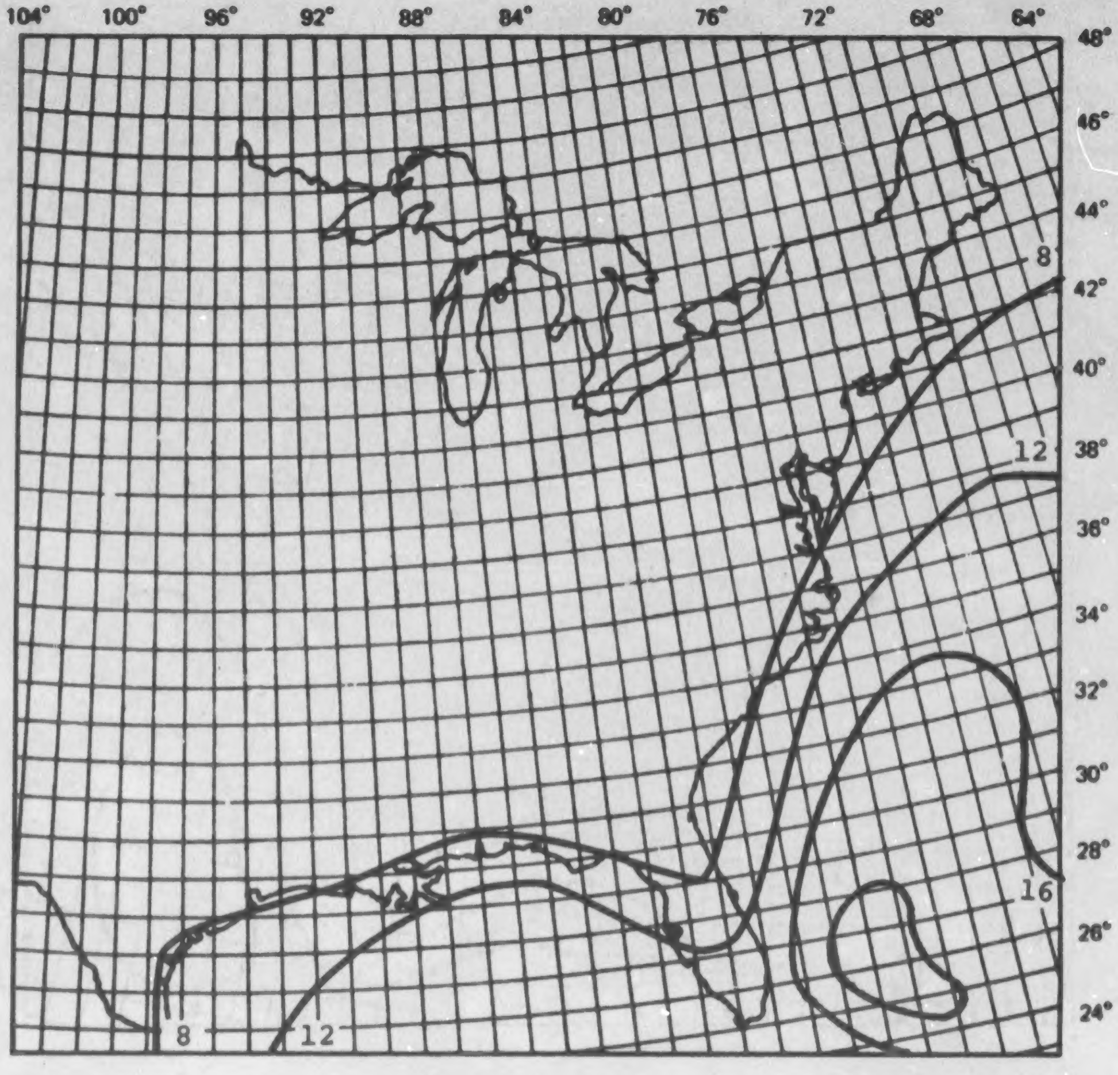

104°
100°
96°
92°
88°
84°
80°
76°
72°
68°
64°
48°
46°
44°
42°
40°
38°
36°
34°
32°
30°
28°
26°
24°
8
12
16
8
12

Figure 3.33 Number of Times in Past 100 Years, Path of a Minimal Hurricane (winds reaching somewhere between 75 and 100 mph sometime during the storm's life cycle). Passed through 1° Latitude by 1° Longitude Squares [3.40].

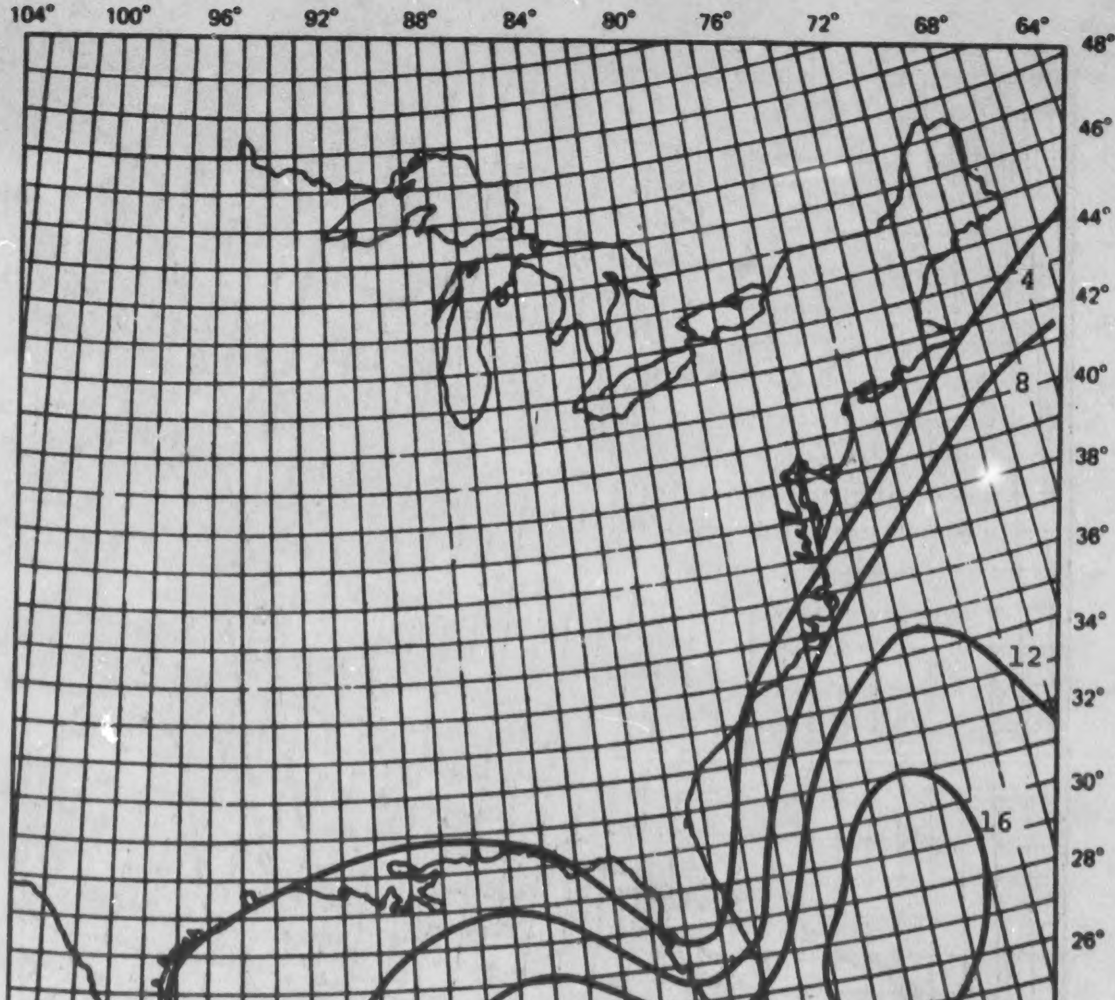

104°
100°
96°
92°
88°
84°
80°
76°
72°
68°
64°
48°
46°
44°
42°
40°
38°
36°
34°
32°
30°
28°
26°
24°
4
8
12
16

Figure 3.34 Number of Times in Past 100 Years, Path of a Major Hurricane (winds reaching somewhere between 101 and 135 mph sometime during the storm's life cycle) Passed Through 1 ° latitude by 1° Longitude Squares [3.40]

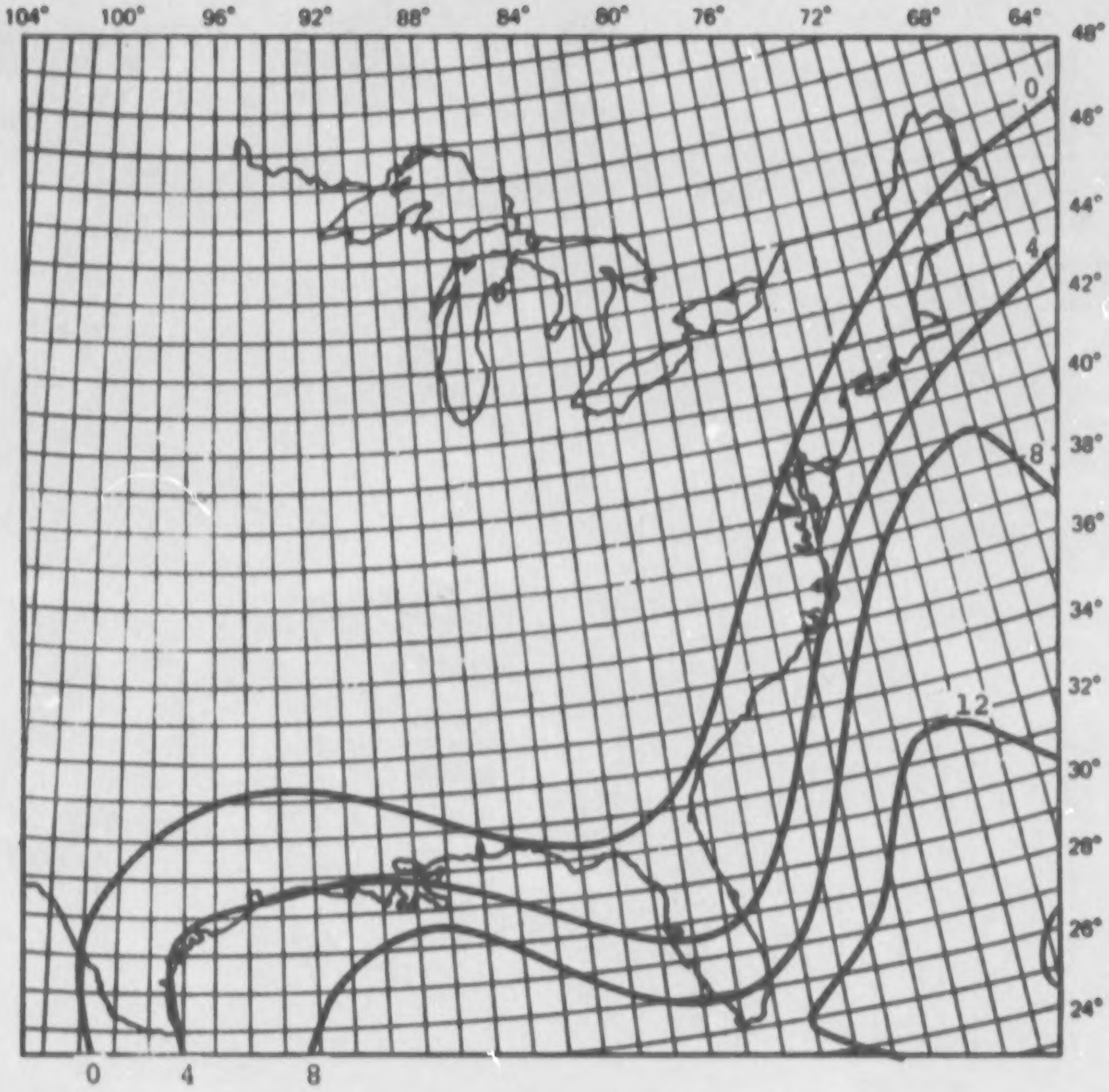

104°
100°
96°
92°
88°
84°
80°
76°
72°
68°
64°
48°
46°
44°
42°
40°
38°
36°
34°
32°
30°
28°
26°
24°
0
4
8
12
0
4
8

Figure 3.35 Number of Times in Past 100 Years, Path of Extreme Hurricane (winds reaching more than 135 mph sometime during the storm's life cycle) Passed Through 1° Longitude Squares by 1° Latitude Squares [3.40]

Since the hurricane data are presented over a range in velocity a kinetic energy balance is necessary to obtain a single numerical value for the velocity in each class. So doing it follows that:

minimal hurricane = 88 mph

major hurricane = 119 mph

extreme hurricane = 139 mph

The user must therefore be guided in his selection of the hurricane wind velocity by the site location, the severity of the hurricane expected and the structures life. Also, when using Friedman's maps to estimate loading due to hurricane winds the assumption of fastest mile of wind measured at 30 feet above the ground must be made for a consistent evaluation using the wind loading program.

E. Structural Characterization

This section presents several structural modeling options which are incorporated in the program. The program requires the user to select which option is appropriate for his particular problem. While later in this section insight is provided into how to make this selection, it is essential to point out that such a selection is often difficult, and no standard rules can be constructed. To think that one can computerize this selection process would be professionally naive because it fails to recognize the individuality exercised by the architect and structural engineer in the building design process. Therefore, while helpful suggestions are offered which are appropriate for a large general class of common buildings, it is important to note that the addition of a small amount of professional input at this stage of the damage prediction procedure by an experienced structural dynamist can produce a significant improvement in the accuracy of the final damage estimate.

Three general levels of detail are offered herein for structural dynamic modeling:

- A detailed model.
- A story-stiffness model.
- An empirical model.

It is noted that all of the modeling options lead to the same basic dynamic characterization: building natural frequencies and modal displacements. These characteristics are used in a manner to be described later.

Detailed Model

Two options are available for the detailed modeling of the building structure. Generally speaking, Option 1 is intended for steel frame type buildings and offers the user convenience in being able to specify standard framing members by code number rather than sectional properties. This option must be used whenever diagonal bracing is present. Option 1 allows for non-rigid joints in the building by permitting framing members to be pinned, with rotational springs inserted at joints to transmit moment.

Option 2 is intended for concrete buildings and must be used to model shear walls since Option 1 has no direct shear-wall modeling capability. Option 2 does not allow for non-rigid joints and does not accommodate diagonal bracing. Otherwise it can be used in place of Option 1. While the beam and column inputs for Option 1 are tailored for steel structures, those in Option 2 are tailored for concrete structures by allowing the user to input characteristic cross-sectional dimensions corresponding to rectangular, circular, I, box and T sections. It is noted that this option will handle buildings with combined steel or concrete frames and shear walls.

Both of the structural models use the stiffness method of structural analysis. Materials are assumed to remain linearly elastic over the range of response. All displacements are assumed to be small compared to the overall dimensions of the structure. All beams and column members must be prismatic and all connections which are not rigid are represented by rotational springs connecting pinned members.

The details of the analytical models are available in the published literature. In particular, for Option 1 the program follows the procedure presented by Lionberger and Weaver [3.41]. That procedure is an extension of an earlier procedure presented by Weaver and Nelson [3.42]. The program used in Option 2 follows the method proposed by Clough, King and Wilson [3.43]. In this method all beams are plane frame members with no axial deformations but with shearing and bending deformations, and all the columns or shear wall elements are treated as vertical frame members. Axial deformations are included for columns and shear walls. It is assumed that plane horizontal sections remain plane as the column or wall deflects. This model is usually referred to as the "deep beam" model for shear walls.

Story-Stiffness Model

The second general level of modeling is called the Story Stiffness Model. If selecting this option, the user must specify a weight, w_i, and a stiffness, k_i, for each ith story. The resulting homogeneous equations of motion for the building have a diagonal mass matrix with elements $m_i = w_i/g$ (g denotes the acceleration of gravity). The building stiffness matrix is banded and takes the form

$$[K] = \begin{bmatrix} k_1 & -k_1 & & & 0 & & \\ -k_1 & (k_1+k_2) & -k_2 & & & & \\ & -k_2 & (k_2+k_3) & -k_3 & & & \\ & & -k_3 & (k_3+k_4) & - & & \\ & & & -k_4 & & - & -k_{n-1} \\ & 0 & & & & & (k_{n-1}+k_n) \end{bmatrix}$$

The numbering convention is such that the stories are numbered from 1 to n, beginning at the top.

Using this method for estimating story stiffnesses the vertical framing members are assumed to deform such that their ends are constrained against rotation.

Empirical Model

The third level of modeling complexity involves the least user time to prepare input but is the least descriptive of the building under consideration. It requires only that the characteristic depth of a building and its height and/or number of stories be specified.

Various investigations and codes attempt to correlate empirical equations for first (fundamental) natural period (T_1) with measured data [3.44-3.49]. It has been the experience of researchers that no one equation can consistently estimate T_1. The variables to be considered are extensive and include: (1) amount, type and distribution of steel or reinforced concrete framing, (2) shear wall or shear wall and frame action, (3) rectangular, L-shaped or U-shaped plan dimensions, (4) the variation of mass and stiffness, (5) the influence of non-structural elements, (6) an assumed dynamic behavior, (7) the extent of soil-structure interaction, and (8) the level of excitation. In fact, regression equations built from data taken in one country, do not necessarily yield good period estimates of buildings in other countries.

Figure 3.36 shows the scatter of first mode period data plotted against the number of stories for U.S. frame structures [3.44, 3.50, 3.51]. Figure 3.37 shows the same trend for shear wall buildings as that for frame structures. All of the San Fernando earthquake data was obtained from reference [3.50] and [3.51].

These remarks serve to preface the suggested equations for estimating fundamental building periods. The equations for T_1 which are programmed are those recommended by the Structural Engineers Association of California (SEAOC) [3.6], see figures 3.36 to 3.38.

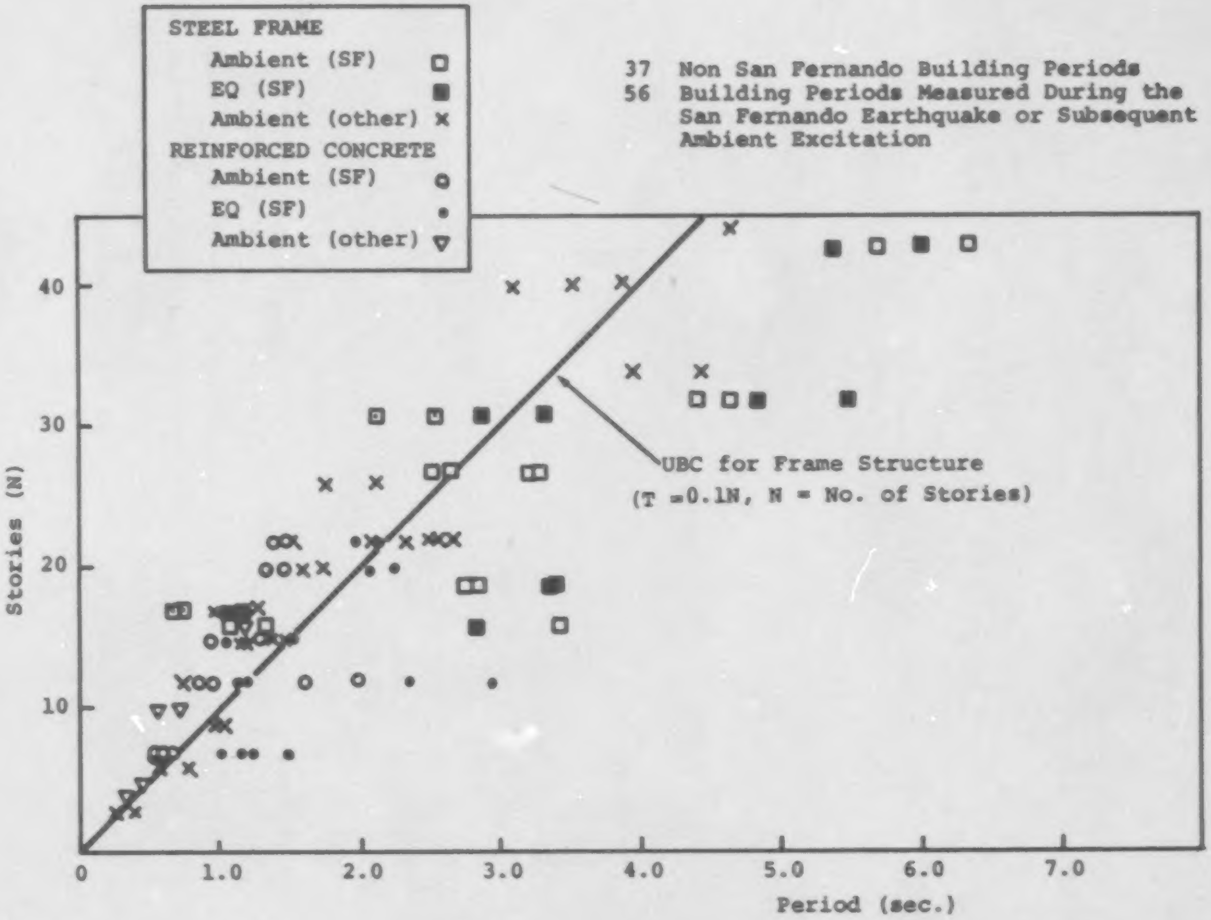
It is noted that the computer program allows the user to input estimates of a building's fundamental natural frequency obtained by any method, including his judgment. Reference [2.9] discusses some experience with using ambient building periods to estimate earthquake building periods.

Selection of Modeling Options

This section provides insight into the selection and usage of the previously discussed structural model. Model selection is usually based upon two underlying considerations: (1) economics associated with input formulation and (2) the modelability of the structure.

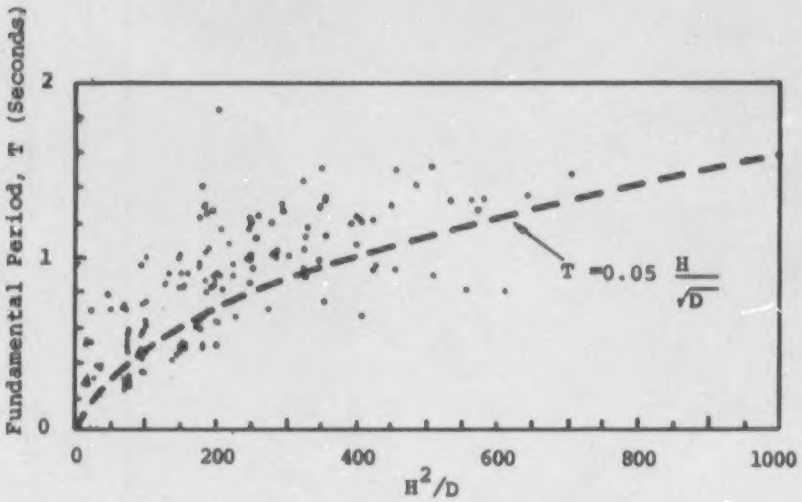
Certain buildings (e.g., modern steel or concrete frames with nonstructural partitions) may be accurately modeled using the detailed analytical model. That is to say that if such an analytical model is developed from the structural plans of the building to include each structural member, then the calculated values of the building's natural periods and mode shapes of vibration can be expected to represent observed behavior.

The engineer may wish an estimate of the building's dynamical properties for a building of the type described above, but may not wish to go to the man-hour expense of compiling and inputting to the computer the data required by such a detailed modeling approach. To answer this desire, the first level modeling option may be employed with the user inputting beam and column structural properties of each floor of a typical structural frame, or structural frame with averaged member properties (rather than representing each frame individually) in each building direction. The structural properties may be obtained in either of two ways.



37 Non San Fernando Building Periods
56 Building Periods Measured During the San Fernando Earthquake or Subsequent Ambient Excitation

Figure 3.36 Period of Frame Structure Compared With UBC Estimator



H = Building Height (ft)

D = Building Depth in Direction of Vibration (ft)

T = Fundamental Period of Buildings

Data source - Ref. 3.49

Figure 3.37 Data Developed for Shear Wall Structures Relating to Period Plotted Together With UBC Code Value for T

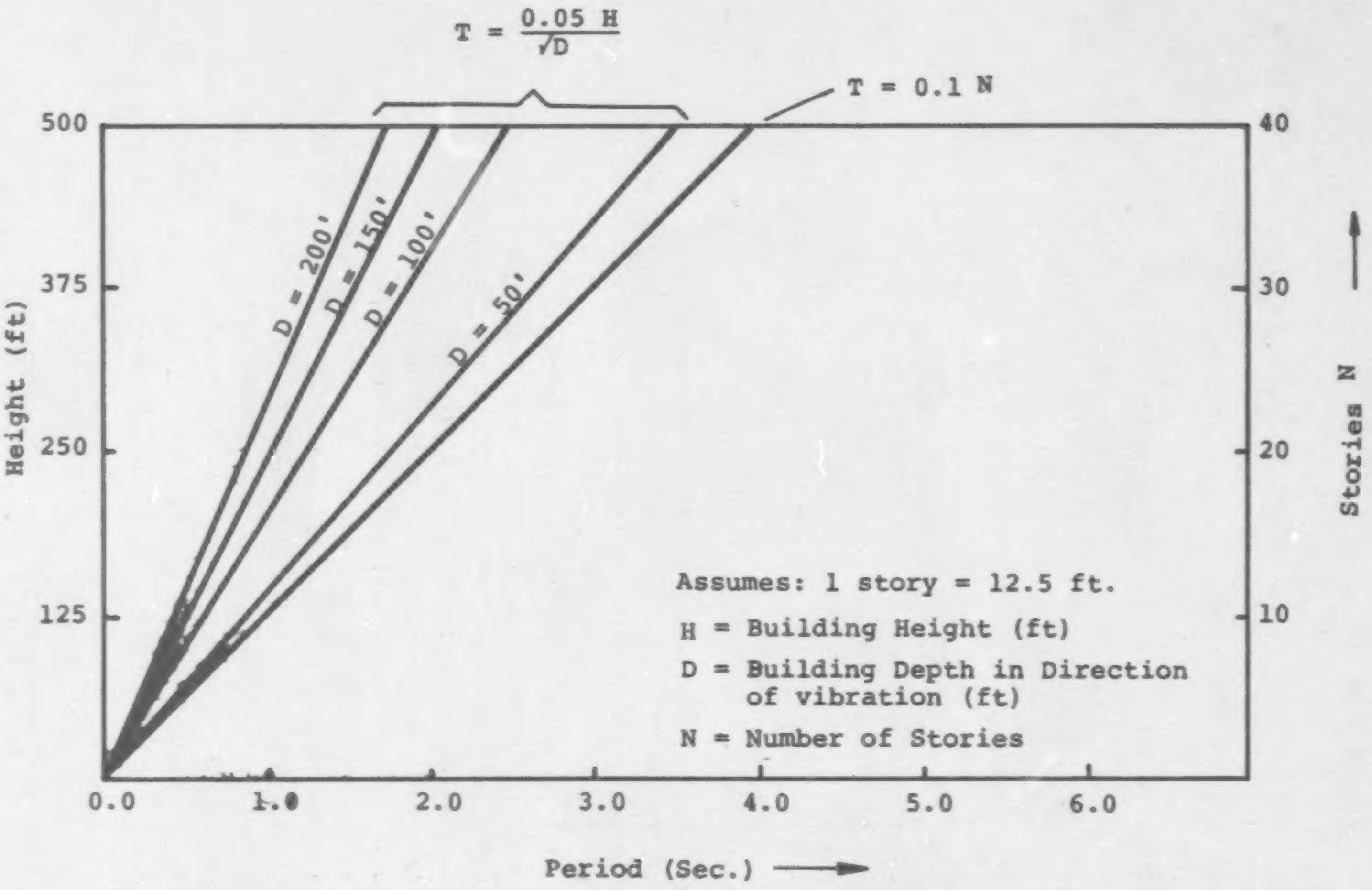


Figure 3.38 Recommended Period Estimations for Frame and Shear Wall Structures

One, an inspection of the structural plans will indicate the appropriate structural properties based on the building's particular framing system and professional experience. Two, a "walk-through" inspection of the building by an experienced structural dynamics engineer can provide rough approximations as to member sizes and hence structural properties for input to the detailed model. Of course, the "walk-through" approach is not recommended unless structural plans do not exist or time dictates its usage.

A second general class of buildings exist which possess partitions which certainly contribute significant lateral stiffness to the building frame. Examples of such partitions are concrete block or brick. To hope to accurately model a particular inhomogenous wall material using a shear wall analytical model may be unrealistic since the partitions are generally not continuous from floor to floor; yet some rational modeling technique must be used. The Story Stiffness Model is recommended for this case. This model requires the engineer to input to the computer program the resultant stiffness of the partition(s) plus frame at each floor. Estimates of these quantities must be made by the engineer. This model is particularly appropriate for low rise buildings which exhibit "shear-beam" behavior as opposed to "cantilever" or "bending-beam" behavior.

Certain buildings are so structurally irregular that the assumptions made to force them to fit into the first two levels of characterization would cause an analytical misrepresentation of their actual dynamic behavior. There also exist many old structures which were built prior to the enforcement of strict inspection procedures and quality control of materials and workmanship that are observed today. These same buildings might also have suffered prior structural damage which has since been masked by plaster and paint. To attempt to characterize such old buildings with an analytical model that inherently assumes adequate construction procedures and no prior damage would be an exercise in futility. In order to permit some sort of rational analysis of the above mentioned structures standard code type formulas are considered to be adequate to estimate their dynamic properties within the framework of the limitations imposed. An alternative to code formulas and certainly recommended would be to conduct full scale testing of the structures for the determination of dynamic and static properties from the measured data. Such a task should certainly be done prior to any building modification dictated by the results of a damage evaluation study.

F. Structural Response

Response to Earthquake Loading - General Comments

The site motion response spectrum for a building site obtained as discussed in section 3.4B is used to calculate maximum seismic response. The user may elect not to use this procedure and the option has been provided for input of any site motion response spectrum. The proposed procedure for calculating building response is a response spectrum approach. A procedure is used wherein damping variations with response level can be accounted for in the analysis. Also, the user of the computer program may, if he desires, with an input option incorporate modifications in the building response spectra which approximate the building's non-linear response behavior. Also, with this option the building's natural periods of vibration are modified based upon the amplitude of interstory displacements.

In order to provide an overview the following steps give a general picture of the response computation procedure which has been programmed.

(1) Calculate building natural periods and mode shapes of vibration.

(2) Set ductility equal to unity for the first response iteration.

(3) Compute modal damping for a building ductility level of one.

(4) Modify base motion response spectra for damping.

(5) If user desires, modify damped structural response spectra for ductility level greater than unity.

(6) Calculate building maximum interstory displacements.

(7) Evaluate the effective building ductility.

(8) Calculate building damping based upon ductility evaluated in (7).

(9) Repeat Steps (4) through (8) until damping and ductility converge.

(10) Calculate maximum values of building response parameters for damage evaluations.

The response spectrum approach for evaluating modal contributions to total dynamic response has been found to yield reasonable engineering approximations in the case of buildings subjected to base excitation [3.5 , 3.52]. The response quantities used in predicting damage include the following:

- Floor acceleration
- Floor velocity
- Interstory displacement

The computer program allows the user to choose any one of three options for calculating spectral response. The options are:

- Fundamental Mode Response
- Root-Sum-Square Response (RSS)
- Absolute Sum Response.

Response to Earthquake Loadings - Response Spectrum Amplification Factors For Damping

The value of structural damping has an effect on the amplification of the basement response spectrum. Figure 3.39 shows a plot of the amplification factor versus damping for each of three regions of the response spectrum. Inspection of this figure leads to three observations. First, amplification is greatest for systems with lower periods. Second, as the damping increases beyond ten percent critical the slope of the amplification plot becomes small and an increase in damping value has relatively little effect upon response maxima. Third, at twenty percent damping all amplifications approach unity.

In reference [3.11] an analysis of 20 earthquake response spectrum, obtained from the California Institute of Technology [3.53], was performed for damping factors of 0, 2, 5 and 20 percent damping. The two horizontal components were studied and the results averaged. The earthquake records used were:

1. El Centro, May 8, 1940
2. Ferndale, October 7, 1941
3. Kern County, July 21, 1952
    - (a) Pasadena
    - (b) Taft
    - (c) Santa Barbara
    - (d) Hollywood Storage basement
    - (e) Hollywood Storage parking lot
4. Eureka, December 21, 1954
    - (a) Eureka
    - (b) Ferndale
5. San Jose, September 4, 1955
6. El Centro, February 9, 1956
7. El Centro, February 9, 1956 aftershock

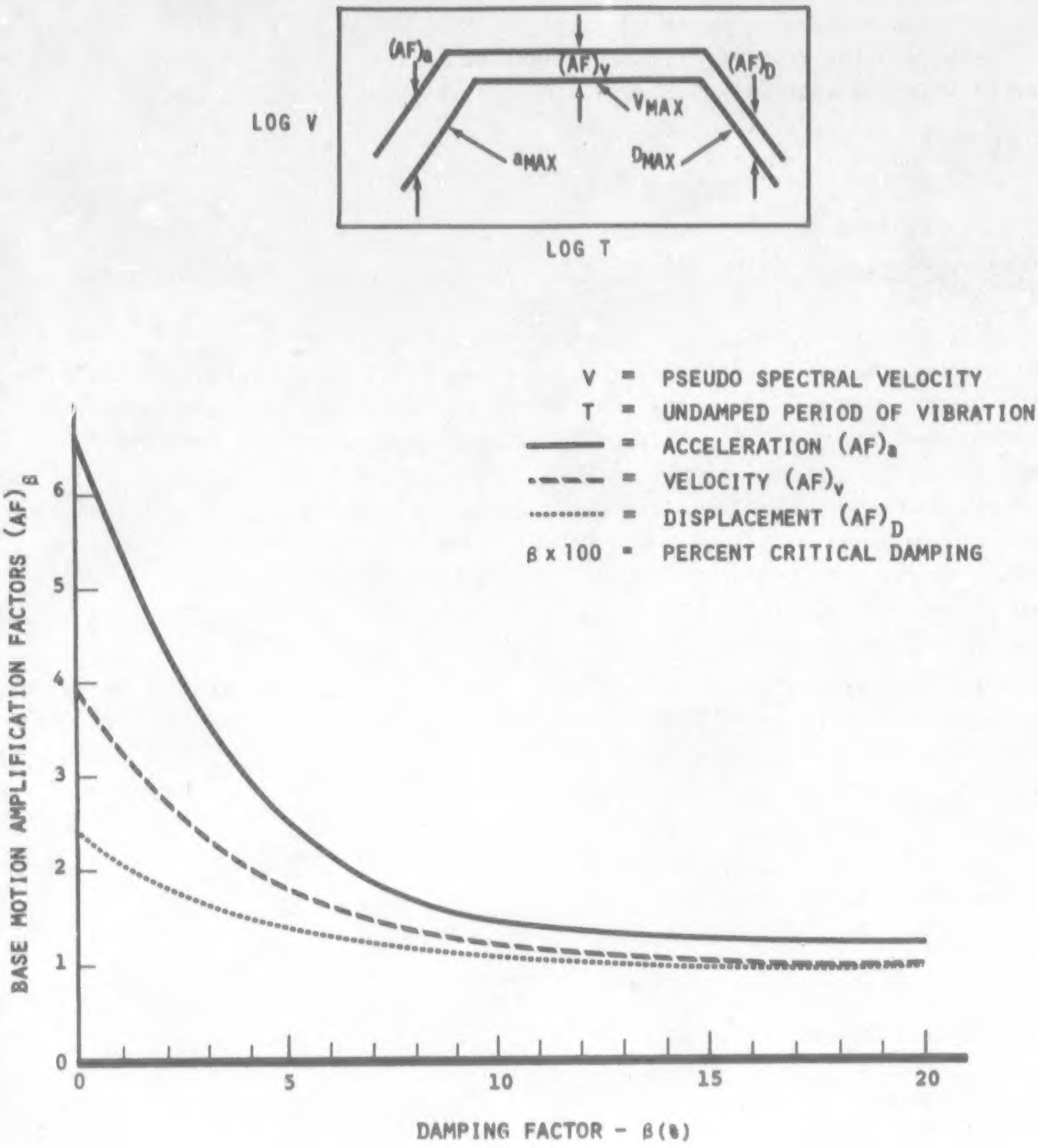


Figure 3.39 Base Motion Amplification Factors vs Various Grades of Damping (After Newmark [3.5])

8. San Francisco, March 22, 1957
   - (a) Southern Pacific Building
   - (b) Alexander Building
   - (c) Golden Gate Park
   - (d) Oakland City Hall
   - (e) San Francisco State Building

9. Hollister, April 8, 1961

10. Borego Mountain, April 8, 1968
   - (a) El Centro
   - (b) San Diego

These earthquakes considered had magnitudes up to 7.7 and hypocentral distances up to 90 miles. The mean pseudo velocity amplification factors obtained from this study are shown in figure 3.40. It is apparent from this figure that a general trend exists for amplification as a function of both natural period of vibration and damping. A smoothing of the curves in this figure produces the following expressions for mean response amplification:

$0 < T_n \leq 0.2$ sec

$$(AF)_\beta = [2.18 - 0.147 \log_{10}(T_n) - 0.633 \log_{10} (\beta \times 100)] \quad (3.4.44a)$$

$T_n > 0.2$ sec

$$(AF)_\beta = [2.28 - 0.633 \log_{10} (\beta \times 100)]\, T_n \quad (3.4.44b)$$

where:

$(AF)_\beta$ = pseudo velocity spectrum amplification factor due to damping

$\beta \times 100$ = percent critical damping

T_n = undamped period of vibration

The amplification factor values exhibit scatter about the mean amplifications shown in figure 3.40. The Coefficient of Variation, C_v, for this sample set of 39 earthquake components was calculated and it is shown in figure 3.41.

The detailed analytical model computer program uses equation (3.4.44) to amplify the site spectrum.

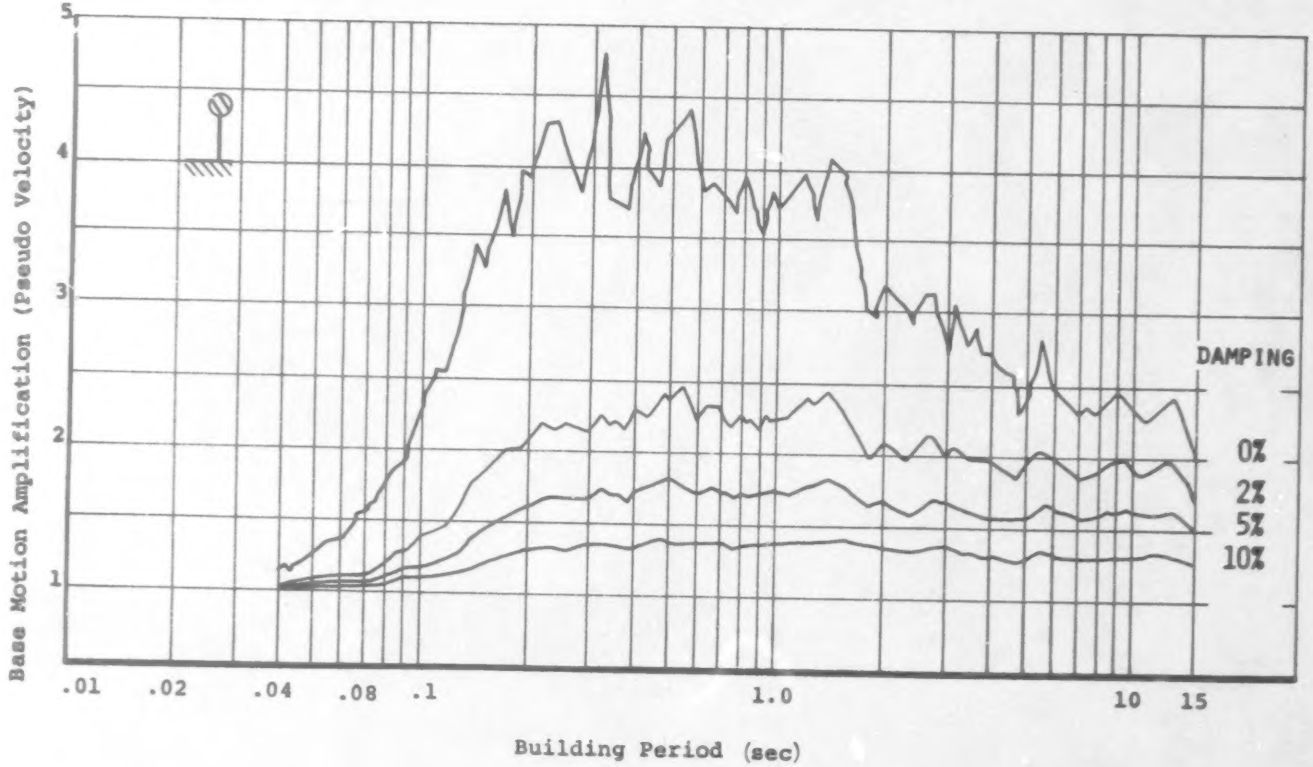


Figure 3.40 Mean Amplification $(AF)_\beta$ Relative to 20% Spectra for Horizontal Ground Shaking

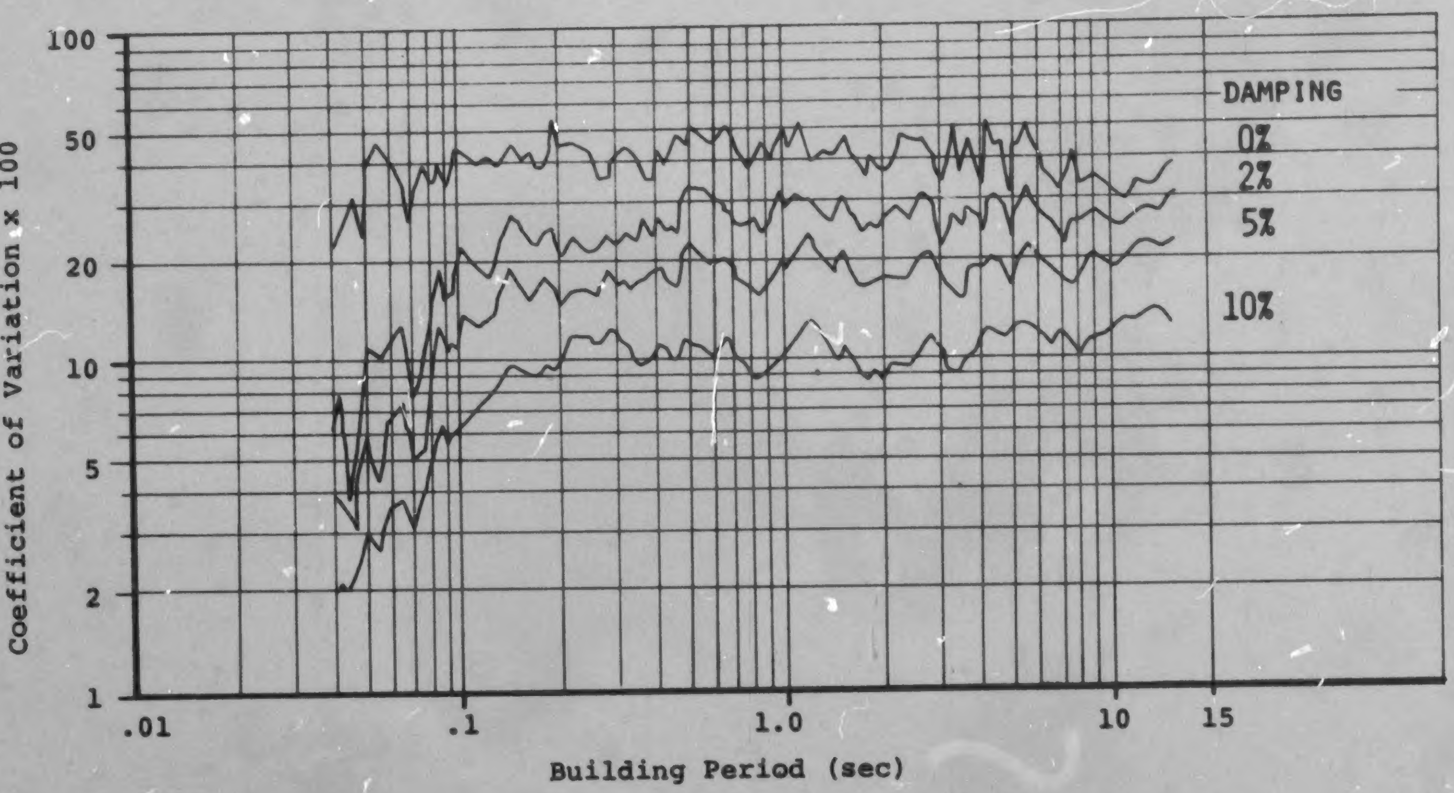


Figure 3.41 Coefficient of Variation of $(AF)_B$ for Horizontal Ground Shaking

Response to Earthquake Loading - Response Modifications for Ductility

Response spectra plots are obtained assuming that the building responds entirely in the linear elastic range. In order to extend its usage beyond the elastic limit several studies have been made [3.54 - 3.56]. These studies have been on elastoplastic single degree-of-freedom systems. For such systems a term called ductility, denoted μ, is defined to be:

$$\mu = \text{ductility} = \frac{(\text{maximum relative displacement})}{(\text{relative displacement at yield limit})}$$

Therefore, for all values of ductility greater than unity the structure responds beyond its elastic limit.

Comparisons made between response spectra computed for elasto-plastic systems and those computed for elastic systems reveal that the two are related by the ductility μ. This result provides a means of adjusting elastic response spectra to compensate for $\mu > 1$. The empirical equations recommended by Newmark [3.54] are given in table 3.14. Refer to figure 3.39 for definitions of $(AF)_a$, $(AF)_v$, and $(AF)_D$.

Table 3.14 DUCTILITY MODIFICATION FACTORS
(After Newmark [3.54])

Response Type Calculated	Pseudo-Velocity Amplification (AF)		
	Acceleration $(AF)_a$	Velocity $(AF)_v$	Displacement $(AF)_D$
Forces	1	$\frac{1}{\sqrt{2\mu-1}}$	$(1/\mu)$
Deflections	μ	$\frac{\mu}{\sqrt{2\mu-1}}$	1

Note that three factors are given depending upon which structural response parameter and spectral domain are considered. The domains are reflected by $(AF)_a$, $(AF)_v$ and $(AF)_D$ and correspond to amplifications of the same type as are shown in figure 3.39. Since Newmark's damping amplification factors are for use in design and hence are inherently conservative, the J. H. Wiggins Company has studied the spectral amplification factors in references [3.54 - 3.56] and have proposed adjustment parameters which reflect an average of the analytical study results. Table 3.15 presents these ductility modification factors and they are the ones used in the computer program.

Table 3.15 DUCTILITY MODIFICATION FACTORS FOR USE IN ANALYSIS

Response Type Calculated	Spectrum Adjustment Factors	
	$T < T_\mu^*$	$T > T_\mu$
Force	$1/\sqrt{\mu}$	$1/\mu$
Deflections	$\sqrt{\mu}$	1

$$^*T_\mu \equiv \frac{2\pi \text{ (Maximum Particle Velocity at Site)}}{\sqrt{\mu} \text{ (Maximum Particle Acceleration at Site)}}$$

In order to extend the use of these single degree of freedom results to multi-story buildings, an effective μ must be computed based upon the response of the building. This may be done by first forming an energy ratio of the maximum elastic strain energy computed from a linearly elastic analysis, to the energy capacity of the building when all floor interstory drifts are equal to the user prescribed yield interstory drift. If the vector $\{z\}$ represents the relative displacement vector associated with the former state, while $\{z\}_y$ represents that of the latter, then the energy ratio is given by

$$\left(\frac{E}{E_y}\right) = \frac{\{z\}^T [K] \{z\}}{\{z\}_y^T [K] \{z\}_y} \qquad (3.4.45)$$

The square root of this ratio represents an average of the ductilities defined at each story and hence what is herein defined as the Effective Building Ductility. Such a ductility is defined as

$$\mu = \sqrt{E/E_y} \tag{3.4.46}$$

In the special case of a single story building,

$$\mu = \sqrt{E/E_y} = \Delta/\Delta_y \tag{3.4.47}$$

according to the usual definition.

Therefore, once a response state is established, equation (3.4.46) may be used to obtain an effective building ductility and then the appropriate values from table 3.15 can be utilized.

The modification of response spectra to incorporate ductility is an area of controversy. Besides the tentative assumption that the structure behaves in an elasto-plastic manner, it is important to recognize that only when the structure responds in a manner where one mode dominates the response that the ductility amplification factors cited in tables 3.14 and 3.15 can be used in a manner consistent with the way in which they were derived. It is recommended that future nonlinear design studies be undertaken to consider the response of actual multi-story buildings.

Response to Earthquake Loading - Amplitude Dependence of Damping

The variation of modal damping value with amplitude of excitation is understood to exist in buildings. Table 3.16 and figure 3.42 show two alternate forms of this amplitude dependence. Herein, damping is expressed as a function of effective building ductility using response data from the February 9, 1971, San Fernando earthquake.

The fundamental mode damping estimates cited in [3.50] were studied on a building by building basis and correlated with each building's effective ductility. This ductility was subjectively estimated using on-the-site damage estimates, computer response studies for the building, and estimated maximum building base shears during the earthquake compared with code design shears. The dots appearing in figure 3.43 represent these damping versus ductility estimates. Because of the considerable scatter in the data, only one curve is used to model the data and it was obtained using a least squares analysis of data for both steel and concrete buildings.

Table 3.16 REPRESENTATIVE DAMPING VALUES
(After Newmark and Hall [3.52])

Stress Level	Type and Condition of Structure	Percentage of Critical Damping
Low, well below proportional limit, stresses below 1/4 yield point	Steel, reinforced or prestressed concrete, wood; no cracking; no joint slip	0.5-1.0
Working stress, no more than about 1/2 yield level	Welded steel, prestressed concrete, well reinforced concrete (only slight cracking)	2
	Reinforced concrete with considerable cracking	3-5
	Bolted and/or riveted steel, wood structures with nailed or bolted joints	5-7
At or just below yield point	Welded steel, prestressed concrete (without complete loss in prestress)	5
	Reinforced concrete and prestressed concrete	7-10
	Bolted and/or riveted steel, wood structures with bolted joints	10-15
	Wood structures with nailed joints	15-20
Beyond yield point, with permanent strain greater than yield point limit strain	Welded Steel	7-10
	Reinforced concrete and prestressed concrete	10-15
	Bolted and/or riveted steel, and wood structures	20

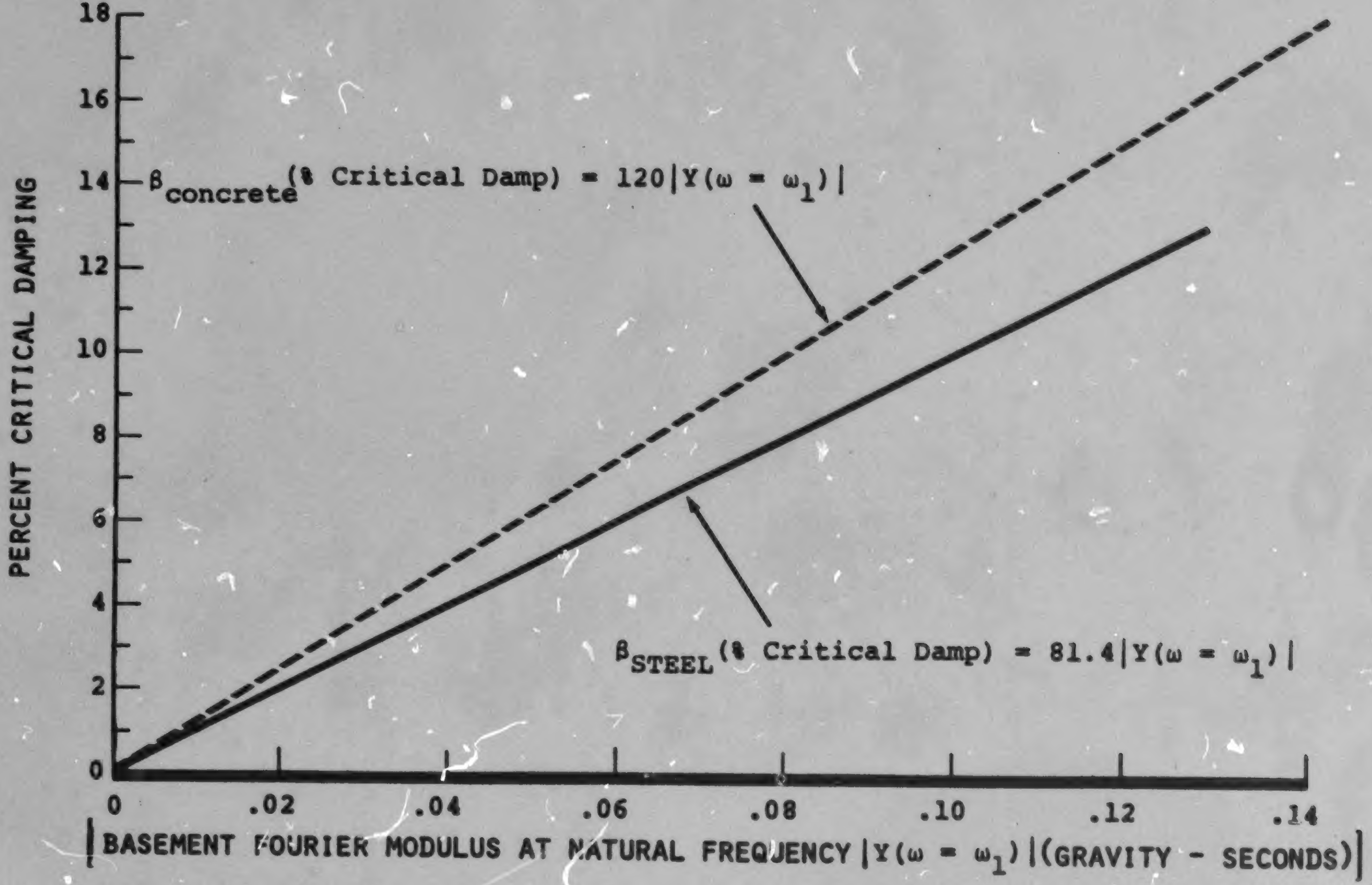


Figure 3.42 Building Damping in Fundamental Mode vs Amplitude (After Hart, Lew, Dijulio [3.50])

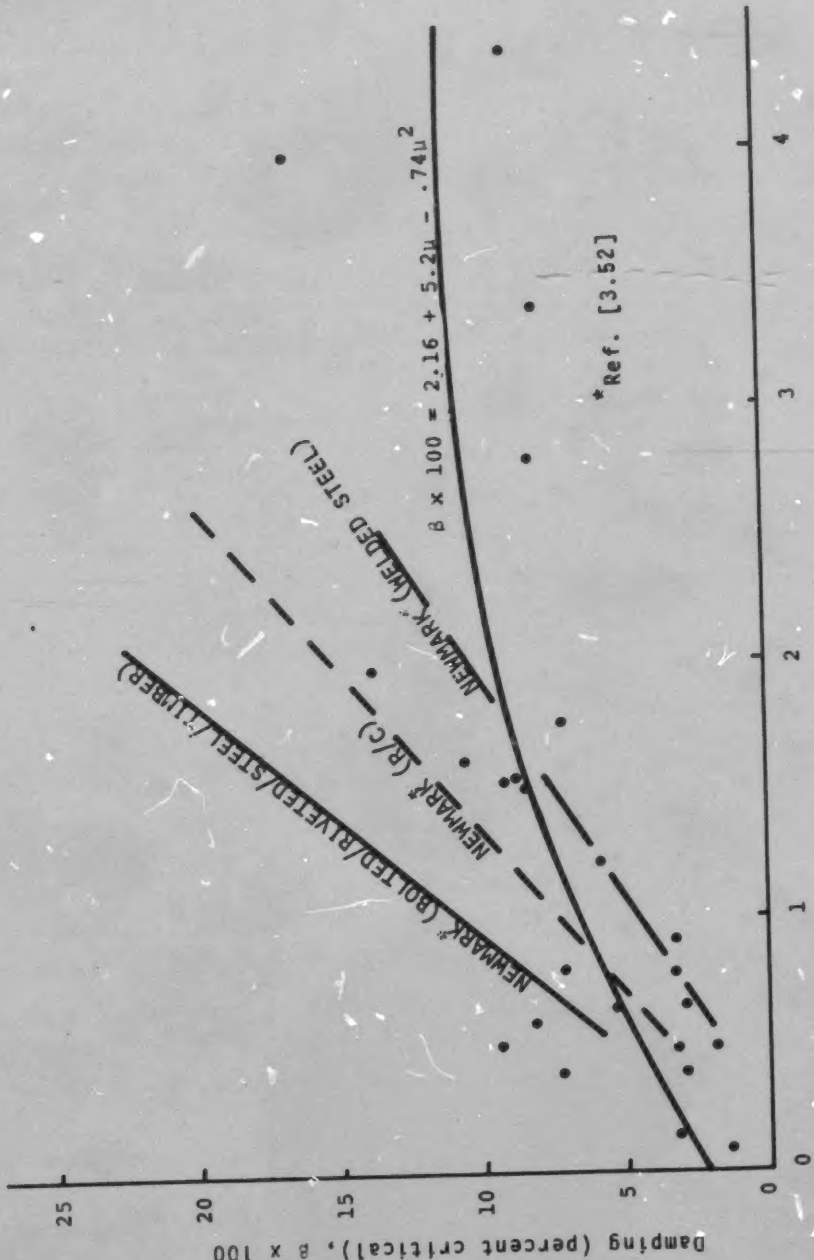


Figure 3.43 Variation of Damping as a Function of Ductility

The curve's equation based upon the San Fernando earthquake data is

$$(\beta \times 100) = \text{percent damping for concrete or steel buildings}$$
$$= 2.16 + 5.2\mu - 0.74\mu^2 \qquad (3.4.48)$$

For timber, bolted and riveted steel buildings, this formula, multiplied by a factor of two, is recommended and programmed for estimating damping. This gross relationship is based on experience [3.52].

Response to Earthquake Loading - Amplitude Dependence of Period

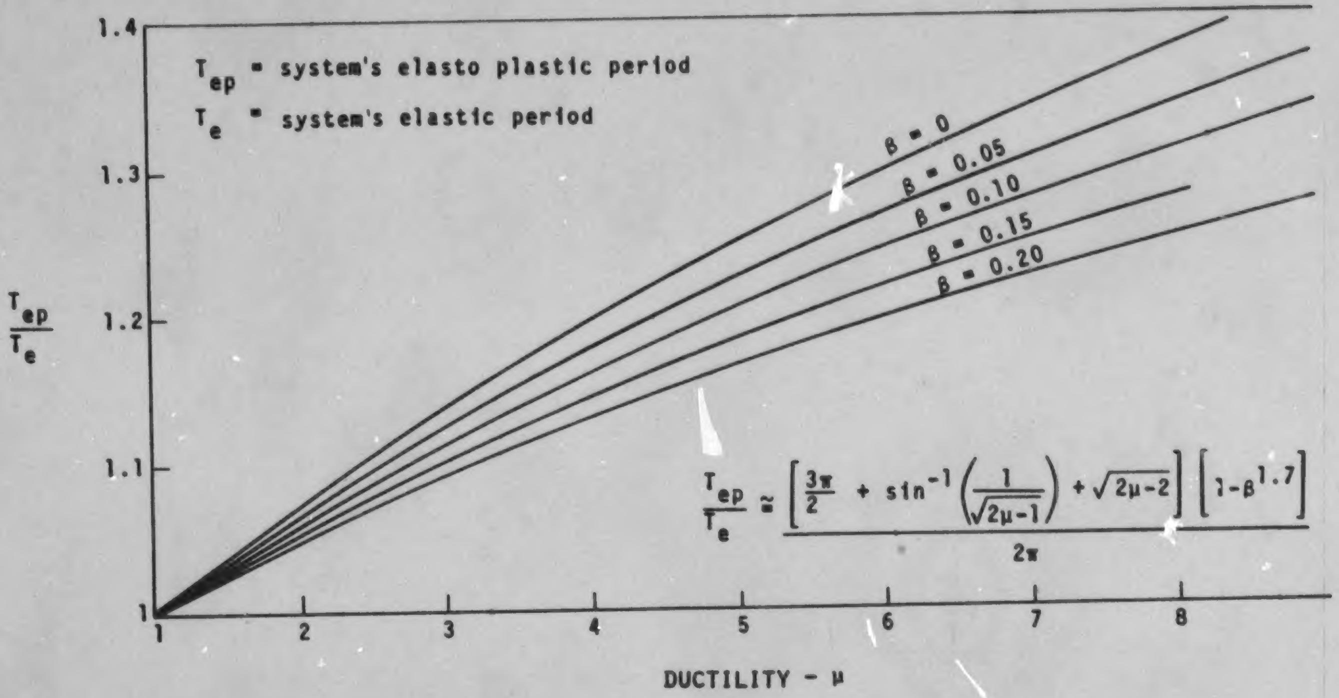
The computer program which preforms a detailed analytical damage analysis allows the user the option of directly including a variation in the magnitude of building period with ductility level. A computer algorithm is included which relates the variation in period with ductility level for an elasto-plastic response model. Appendix C of [3.11] presents the original work of W. T. Thomson in this area and figure 3.44 summarizes his findings. The computer algorithm utilizes the equation noted in this figure.

Response to Wind, Tornado and Hurricane Loading

As discussed in section 3.40 the wind loads acting on a building are a function of the building's fundamental natural period of vibration and damping. The latter quantity must be input by the user to the computer program whereas the former is evaluated using any one of the three characterizations detailed in section 3.4E. The user is advised to estimate the building damping using his professional experience and, because of the lack of damping estimates during strong winds, to use damping values from seismic response studies. The forces acting on the building, while static in character, are a function of the dynamic parameters of the building. Both tornado and hurricane loads are based upon wind loads resulting from a prescribed wind velocity and therefore the response procedure for these types of natural disasters does not differ from that used for strong winds.

A force vector {F} is computed from a net pressure distribution along the building by multiplying the pressure at each story, P_i, by the tributary story area A_i. Thus, the wind pressure force F_i acting at the ith story is

$$F_i = P_i A_i \qquad (3.4.49)$$



$$\frac{T_{ep}}{T_e} \approx \frac{\left[\frac{3\pi}{2} + \sin^{-1}\left(\frac{1}{\sqrt{2\mu-1}}\right) + \sqrt{2\mu-2}\right]\left[1-\beta^{1.7}\right]}{2\pi}$$

Figure 3.44 Ratio of Elastoplastic to Elastic Periods [3.11]

A displacement vector {z} is computed from the matrix equation

$$\{z\} = [K]^{-1} \{F\} \qquad (3.4.50)$$

where [K] is the building's stiffness matrix. The interstory drift due to wind loading is given by the vector {Δ} where

$$\Delta_i = \begin{cases} z_{i+1} - z_i & : i < n \\ z_i & : i = n \end{cases} \qquad (3.4.51)$$

If the detailed or story stiffness characterization option is chosen, see section 3.4E, then the building stiffness matrix is calculated directly. However, if the empirical modeling option is chosen then only the building's fundamental period of vibration and mass are available. In this latter case the building response is calculated using a simplified analysis. Considering the building to be a uniform cantilever beam its fundamental period of vibration can be expressed in terms of the roof deflection if the beam is assumed to be acted upon by a uniformly distributed loading, i.e.,

$$T_n = \text{fundamental period of cantilever beam} = \frac{2\pi l^2}{3.52}\sqrt{\frac{w}{EIg}}$$

and

δ = deflection at the end of a uniform fixed-end cantilever beam subjected to a static uniform load equal to the total beam weight divided by the beam length (i.e., building weight/building height)

$$= wl^4/8EI$$

therefore

$$\delta = (3.89\ T_n)^2 \text{ inches} \qquad (3.4.52)$$

Since the total wind force acting on the building is known from the load generation part of the program the total deflection at the top of the building is calculated to be

$$Z_1 = \text{deflection at top of building}$$

$$= \left[\frac{\text{(Total Wind Force on Building)}}{\text{(Total Weight of Building)}}\right] \delta \qquad (3.4.53)$$

A straight line deformation shape is assumed to obtain interstory displacements. This approach is very simple and involves assumptions which can be eliminated if the user goes to the extra effort of using a story stiffness model.

G. Earthquake Damage Evaluation Methodology

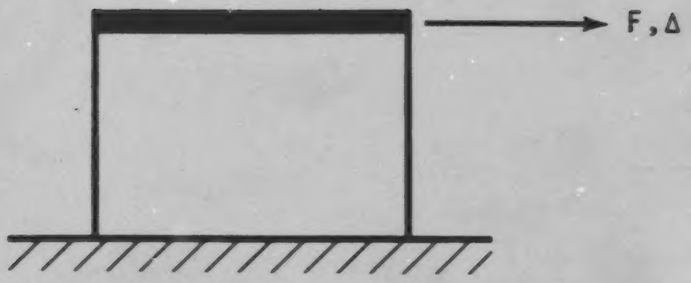
This section presents the methodology which is used to evaluate the damageability of a building due to earthquake excitation. Two Damage categories are considered - structural and nonstructural. Structural damage is based upon the calculated level of interstory drift. Nonstructural partition damage is based upon the level of floor velocity and acceleration via an Effective Floor Modified Mercalli Intensity and window damage is dependent upon interstory drift. All types of damage are estimated on a floor-by-floor basis.

Prior to proceeding with the details of the earthquake damage algorithm, a general discussion of the philosophy behind the approach seems appropriate.

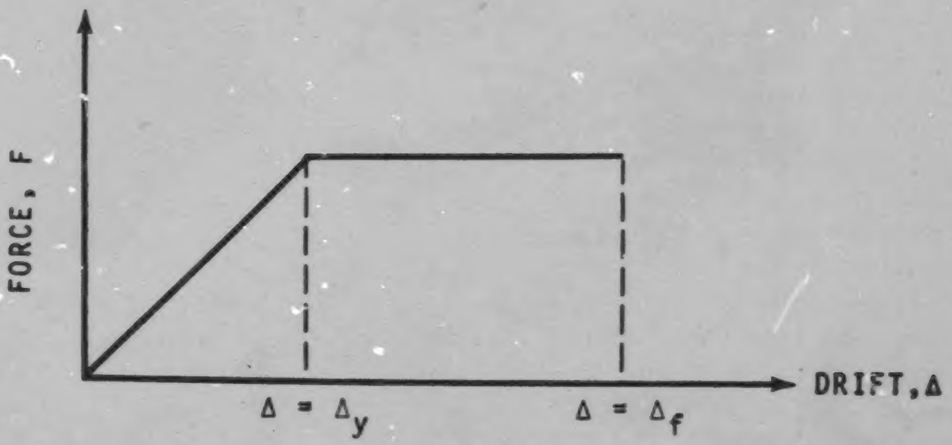
Any engineer who has performed laboratory tests realizes that the response level at which a test specimen fails is a random variable. Stated differently, the value of the response level at failure is not the same for all test specimens. The scatter in the values of the failure response levels usually has a central tendency, and engineering experience indicates that the scatter in failure values tends to be distributed about this mean in a bell-shaped form.

The following hypothetical example is used to clarify the point. A frame (see figure 3.45) is acted upon by a force, denoted F. As the magnitude of the force is increased, the frame deflects laterally and its value, denoted Δ, increases. At a drift of $\Delta = \Delta_y$ the frame reaches its yield point, and at the greater drift value of $\Delta = \Delta_f$, the frame reaches failure. Now, imagine that this experiment is repeated many times (say, 100 for this hypothetical example) and the magnitude of the failure drift is recorded for each experiment. If these 100 failure data points are plotted against Δ_f and a smooth curve drawn through them one would expect them to follow a bell-shaped curve as indicated in figure 3.46(A). Figure 3.46(B) shows the same data presented in an alternate from where the area under the curve in figure 3.46 (A) to the left of Δ_f represents the cumulative percentage of failures of levels up to and including Δ_f. The vertical axis of the plot in figure 3.46(A) is labeled the "Probability Density of Failure" and the vertical axis of the corresponding S-shaped curve in figure 3.46(B) is labeled "Percentage of Specimens failing at drift $\leq\Delta_f$." Mathematical expressions can be written for both of these curves. It follows that if one defines

$$X \equiv \Delta_f \text{ and } \overline{X} \equiv \overline{\Delta}_f$$

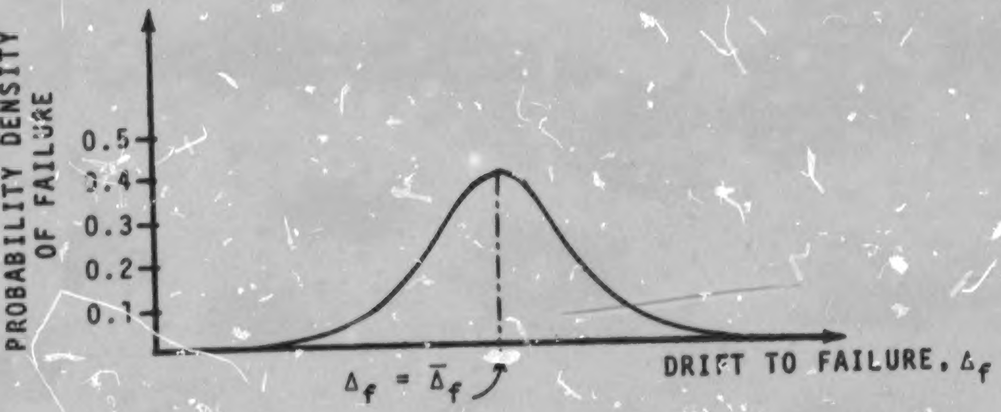


(A) SIMPLE FRAME

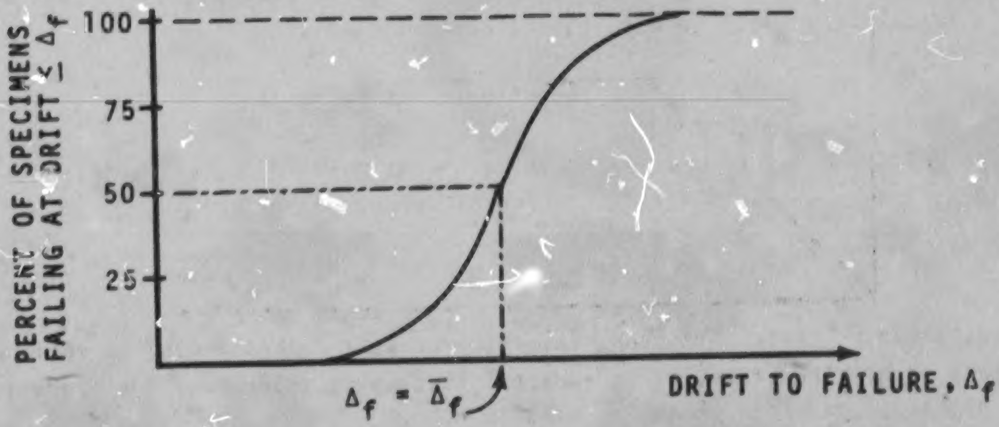


(B) FORCE - DRIFT CURVE

Figure 3.45 Description of Hypothetical Example



(A) BELL-SHAPED FAILURE CURVE



(B) S-SHAPED FAILURE CURVE

Figure 3.46 Failure Curves

then for the Bell-shaped curve in figure 3.46(A), one has

$$f(X) = \frac{1}{\sqrt{2\pi}\ \sigma} \exp\left\{ -\frac{1}{2}\left[\frac{X - \bar{X}}{\sigma}\right]^2\right\} \qquad (3.4.54)$$

and corresponding to the S-shaped curve in figure 3.46(B), one has

$$F(X) = \frac{100}{\sqrt{2\pi}\ \sigma} \int_0^X \exp\left\{ -\frac{1}{2}\left[\frac{Z - \bar{X}}{\sigma}\right]^2\right\} dZ \qquad (3.4.55)$$

It is apparent from an inspection of equations (3.4.54) and (3.4.55) that

$$F(X) = 100 \int_0^X f(Z)dZ \qquad (3.4.56)$$

The curves defined by equations (3.4.54) and (3.4.55) are the well-known Normal Density and Distribution curves. In the above equations the two constants $\bar{X}$ and σ are given the special names of:

σ = standard deviation of failure
$\bar{X}$ = mean failure

The mean is the central tendency parameter and the standard deviation is the dispersion parameter. Large values of standard deviation mean a flatter bell-shaped curve. An important parameter which is often used in place of the standard deviation because of its nondimensionality is

$$C_v = \frac{\sigma}{\bar{X}} = \text{coefficient of variation} \qquad (3.4.57)$$

The significance of the numerical value of the coefficient of variation is evident from a study of F(X) at different values of N where

$$X = \bar{X}\ (1 + NC_v) \qquad (3.4.58)$$

In particular, table 3.17 shows the value of F(X) corresponding to various values of N. Therefore, it is apparent that as C_v increases, the product of NC_v increases without an increase in N.

TABLE 3.17 FAILURE PERCENTAGE VERSUS RESPONSE LEVEL

$\left(\frac{X - \bar{X}}{\sigma}\right)$	Percentage of Specimens Which Have Failed F(X)	Percentage of Specimens Which Have Not Failed 1-F(X)
0.0	50.0	50.0
0.5	69.2	30.8
1.0	84.1	15.9
1.5	93.3	0.7
2.0	97.7	2.3
2.5	99.4	0.6
3.0	99.9	0.1

The preceding discussion outlines the classic introduction of the cumulative probability distribution curve. However, a somewhat different point of view is adopted herein for its application to damage estimation. For a particular building, one is not interested in the distribution of failure characteristics with respect to a field of 100 identical buildings. The concern, rather, is with the percentage of structural elements or components which fail in a single building as a function of its response level. In general, many structural members comprise the primary or secondary structure of one story of a building. As the building responds to earthquake induced ground motion, the structural elements in that particular story are strained to varying degrees for a single value of interstory drift, Δ. As interstory drift increases, the strain in each member increases and corresponding to three levels of drift, say $\Delta_1 < \Delta_2 < \Delta_3$, one may find that 1%, 5% or 30% of the structural members at that story are strained to their ultimate capacity and therefore fail. Equation (3.4.55) is used to characterize this percentage of structural members failing at a particular floor level for a specified amplitude of interstory drift. In particular, if the interstory drift is equal to $X = X_o$ and C_v and X have been defined then the percentage of structural components or members which will fail is $F(X = X_o)$, i.e.,

$$F(X = X_o) = \frac{100}{\sqrt{2\pi}\,\bar{X}C_v} \int_0^{X=X_o} \exp\left[-\frac{1}{2}\left[\frac{Z-\bar{X}}{\bar{X}C_v}\right]^2\right] dZ \quad . \; . \; . \; . \; . \quad (3.4.59)$$

Structural Damage

The extent of structural damage experienced by a building during an earthquake is expressed on a floor-by-floor basis. For each floor of the building a percentage of damage between 0 and 100 is calculated which reflects the percent of structural members which fail for that floor (0 percent is no damage and 100 percent is complete damage). This damage is dependent upon (1) calculated interstory drift, denoted Δ; (2) interstory drift to yield, denoted Δ_y; (3) ductility of component which can be expected prior to failure, μ_f; (4) duration of motion at significant response levels. Also inherent in the selection of a component's drift to yield and ductility to failure is its quality. This subjective factor will be discussed later, however, for the present discussion it is sufficient to note that the quality of the structure is dependent upon its construction materials, supervision during construction, etc. Insight into the selection of numerical values for Δ_y and μ_f is discussed later.

The response parameter used to indicate the extent of structural damage is story ductility. Story ductility, μ_i, is calculated using the equation

$$\mu_i = \frac{\Delta_i}{(\Delta_y)_i} \qquad (3.4.60)$$

where

Δ_i = calculated interstory drift of ith story

$(\Delta_y)_i$ = user specified interstory drift to yield of ith story

The interstory drift Δ_i is calculated in the structural response module of the computer program and the interstory drift to yield (Δ_y) is input by the user. Attention is now turned to response capacity.

The ductility which a structural component can experience prior to failure in a single load to failure test is denoted μ_f. This ductility value corresponds to a monotonic loading to failure. To reconcile the difference between a laboratory monotonic test value and a ductility to failure that an in-place building member can experience prior to failure, Wiggins and Moran have proposed the following formula based upon a regression analysis of elasto-plastic response (see [3.11], Appendix K).

$(\mu_c)_i$ = ductility to failure during an earthquake of Richter magnitude M for a building with fundamental period T_1.

$$= \left[\frac{T_1}{.0046\ e^M}\right] (\mu_f)_i;\ 1 \leq (\mu_c)_i \leq (\mu_f)_i \qquad (3.4.61)$$

The concept of this factor (μ_c) is an important one and studies should be made to see if the above relationship is appropriate for a wide range of force-deflection relationships. To better understand this factor consider figure 3.47. Because of the cyclic nature of dynamic structural response the structural component can reach its failure ductility level with one single large cycle of motion, or alternately from the cumulative yielding effect of several cycles of response. This cumulative effect results from the properties of the structural components. A pictorial representation of this characteristic is shown in figure 3.47. In the earthquake problem the transient character of the response (usually less than one minute of strong motion) can allow the structure to undergo yielding and yet it is possible that the component may never reach the failure drift level.

The building period and Richter magnitude which are to be used in this equation have been specified or calculated as part of the Earthquake Loading Module. This formula reduces the ductility to failure based upon the number of cycles of fundamental mode response experienced by the building components during the strong motion phase of the earthquake.

It is recognized that the value of ductility to failure will vary among the various structural members comprising any given story. To account for this dispersion a parameter, denoted C_v, is defined and associated with $(\mu_c)_i$. This parameter may be interpreted as a coefficient of variation when damageability is interpreted probabilistically.

Once this coefficient is specified and assuming that the ductility to failure is a normally distributed curve (i.e., S-shaped) then the percent structural damage associated with the ductility at any floor level is uniquely determined, see figure 3.48. The equation for the percent structural damage at the ith floor is

$$\begin{bmatrix}\text{Percent Damage}\\ \text{(ith floor)}\end{bmatrix} = \frac{100}{\sqrt{2\pi}(\mu_c)_i(C_v)_i} \int_0^{\mu_i} \exp\left\{ -\frac{1}{2}\left[\frac{Z-(\mu_c)_i}{(\mu_c)_i(C_v)_i}\right]^2 \right\} dZ \quad ..(3.4.62)$$

where

$(C_v)_i$ = coefficient of variation of $(\mu_c)_i$ for the ith floor

μ_i = calculated ductility of the ith floor

Nonstructural Damage

The estimation of nonstructural damage in a building during an earthquake is a very difficult problem. Historical damage data have not differentiated between the financial loss associated with structural and nonstructural damage (see Appendix H of [3.11]). However, it is apparent that there exists a correlation between nonstructural damage and such factors as (1) level of absolute floor acceleration, (2) level of interstory displacement and (3) the quality of the building.

The approach taken herein to estimate nonstructural damage is based upon past research in single family dwelling damage estimation and professional engineering judgment.

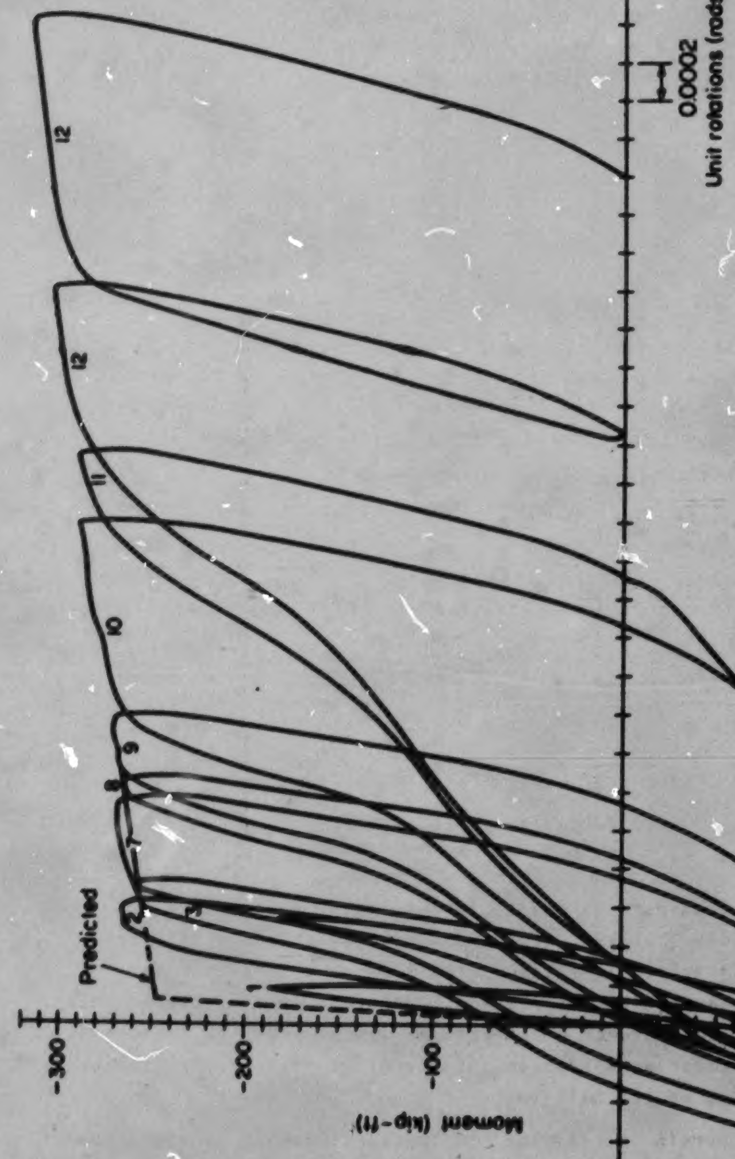


Figure 3.47 Typical Load Deflection Pattern For Structural Member

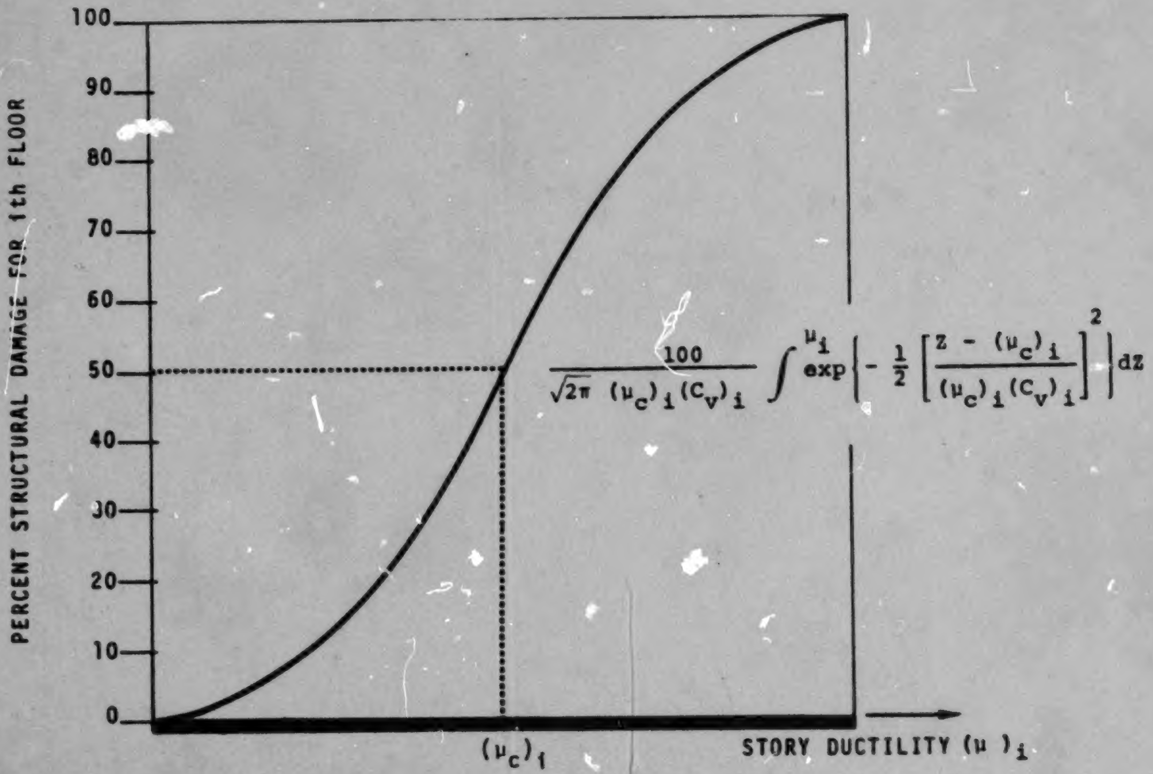


Figure 3.48 Structural Damage Versus Ductility

First, a general correlation exists between site Modified Mercalli Intensity and nonstructural damage (see table 2.1). Second, empirical relationships exist between Modified Mercalli Intensity and maximum site acceleration and velocity, see equations (3.4.20) and (3.4.21). Therefore, the presented nonstructural damage estimation procedure considers each floor of the building to be a potential damage site. The building response calculations produce for each floor the maximum acceleration and velocity and therefore these are used in

$$I_i = 3.50 \log_{10}(A_i) + 10.28 \qquad (3.4.63a)$$

$$I_i = 2.73 \log_{10}(V_i) + 5.16 \qquad (3.4.63b)$$

where

V_i = maximum velocity of ith floor (in/sec)

A_i = maximum acceleration of ith floor (g's)

to estimate the Effective Floor Modified Mercalli Intensity, I_i. Since two intensities are possible, the computer program takes the maximum intensity from equation (3.4.63) and estimates the percent non-structural loss for each floor using the equation

$$\begin{bmatrix}\text{Percent Damage}\\ \text{(ith floor)}\end{bmatrix} = 10^{\left[-4.62 + 0.552\, I_i \left(1 - \frac{Q_i - 3}{6}\right)\right]} \qquad (3.4.64)$$

where

I_i = Effective Modified Mercalli Intensity of ith floor

Q_i = Quality Factor for the ith floor (to be discussed in later paragraphs).

Equation (3.4.64) is an empirical equation and is an extension of an earlier formula [1.1] where the inclusion of the building quality factor into the equation represents the extension. The empirical constants in (3.4.64) were obtained from a regression analysis of the data presented in [3.57 - 3.59].

The nonstructural damage associated with window breakage is calculated in a separate computer module. Glass damage results from distortion in the window frame of the type shown in figure 3.49.

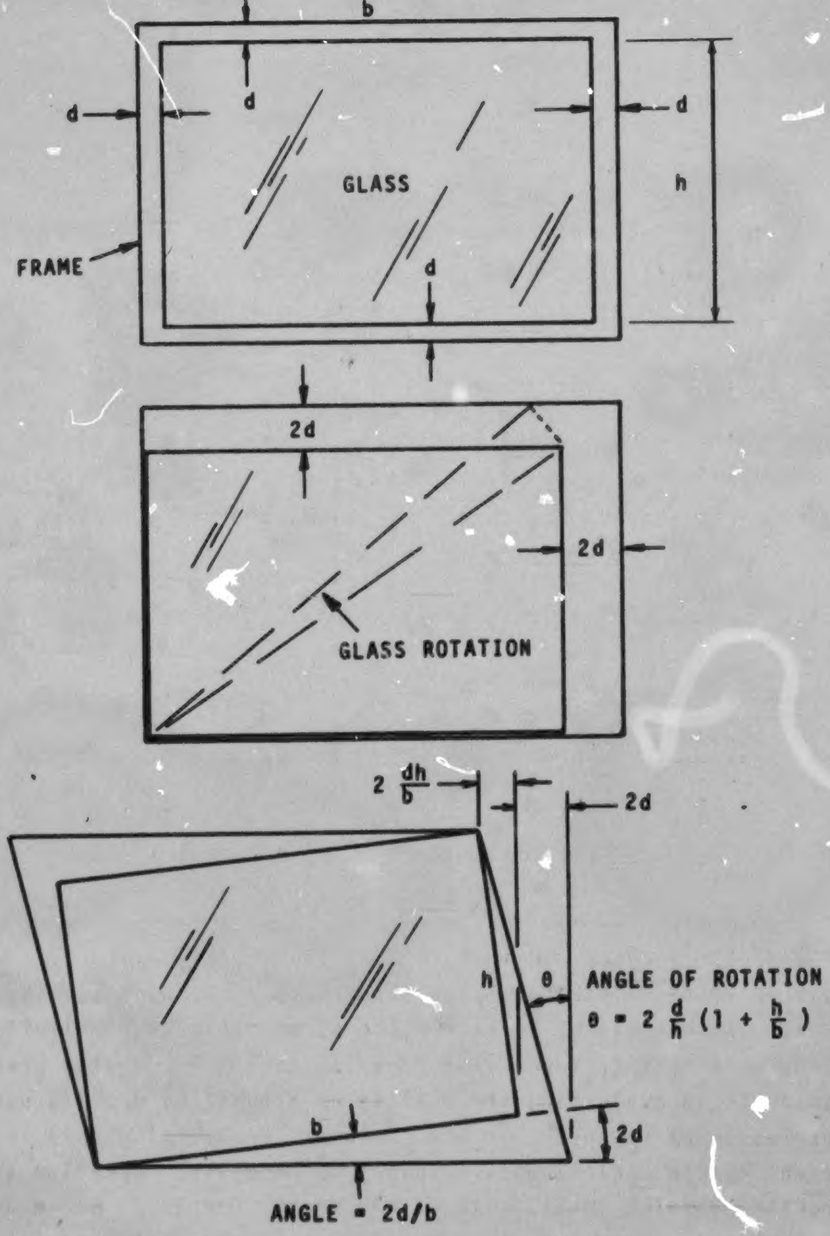

b
d
d
d
GLASS
h
FRAME
d
2d
2d
GLASS ROTATION
2 $\frac{dh}{b}$
2d
h
θ
ANGLE OF ROTATION
$\theta = 2\,\frac{d}{h}\,(1 + \frac{h}{b})$
b
2d
ANGLE = 2d/b

Figure 3.49 Glass Rotation Conditions

The selected algorithm for window damage is based on an uncertainty model concerning the binding or degree of fixity of a window as it cracks during an earthquake. An assumption is that the glass breaks when it reaches the drift value

$$(\Delta_G)_i = \frac{2d_i}{h_i}\left(1 + \frac{h_i}{b_i}\right) \qquad (3.4.65)$$

where:

d_i = mean clearance of mullions on the ith floor windows

h_i = mean height of windows on the ith floor

b_i = mean width of windows on the ith floor

$(\Delta_G)_i$ = drift to failure of window glass on the ith floor

Uncertainty in the mean mullion clearance, d_i, produces uncertainty in the window drift to failure, $(\Delta_G)_i$. Therefore, it is readily apparent that associated with a calculated interstory drift for the ith floor, Δ_i, one can obtain a percentage of windows broken which depends, in addition to the above parameters, upon the coefficient of scatter of the drift to failure of the glass, $(C_{VG})_i$. The percent of windows broken at the ith floor may be expressed as.

$$\begin{pmatrix}\text{Percent of Windows}\\ \text{with broken glass}\\ \text{on ith floor}\end{pmatrix} = \frac{100}{\sqrt{2\pi}\,(\Delta_G)_i(C_{VG})_i}\int_0^{\Delta_i} \exp\left\{-\frac{1}{2}\left[\frac{Z-(\Delta_G)_i}{(\Delta_G)_i(C_{VG})_i}\right]^2\right\}dZ \qquad (3.4.66)$$

Building Quality Factors

The previous section introduced the concept of a building quality factor, and it was noted that the level of both structural and nonstructural damage depends upon this factor. Therefore, to give the computer program user some guidance in evaluating the quality of a building and its parts, qualified professional engineers in the field of structural damage investigations present herein their judged opinions of "Quality" regarding structural and nonstructural elements. These engineers, Donald F. Moran and Roy G. Johnston have prepared table 3.18 for the structural materials most commonly encountered in practice. Donald F. Moran prepared quality rating table 3.19 for nonstructural categories.

TABLE 3.18 QUALITY RATING OF MATERIALS IN STRUCTURAL SYSTEM (a. Strength)

Material	Quality		
	Good Q = 3	Average Q = 2	Poor Q = 1
Structural Steel & Metal Decking	$f_y \geqq 40$ ksi	$f_y \geqq 30$ ksi	$f_y < 30$ ksi
	Double sheet metal decking	Single sheet metal decking	Cast iron Corrugated Iron
Concrete: Including Precast & Prestressed	$f'_c \geqq 3$ ksi	$f'_c \geqq 2$ ksi	$f'_c < 2$ ksi
Masonry (Based on core tests or specified strengths)	$f'_m \geqq 2.0$ ksi	$f'_m \geqq 1.2$ ksi	$f'_m < 1.2$ ksi
	Mortar $f'_c \geqq 2.0$ ksi	Mortar $f'_c \geqq 1.0$ ksi	Mortar $f'_c < 1.0$ ksi
			Old sand-lime mortar
	Grout $f'_c \geqq 2.0$ ksi	Grout $f'_c \geqq 1.0$ ksi	Grout $f'_c < 1.0$ ksi
	Continuous Inspection	Called Inspection	No Inspection
Timber Plywood	$f_b \geqq 1.9$ ksi	$f_b \geqq 1.5$ ksi	$f_b < 1.5$ ksi
	Select Structural	Construction Industrial	Not Grade Marked
	Structural I Plywood	Structural II Plywood	Plywood not grade marked
Gypsum	$f'_g \geqq 1.0$ ksi	$f'_g \geqq 0.5$ ksi	$f'_g < 0.5$ ksi

TABLE 3.18 QUALITY RATING OF MATERIALS IN STRUCTURAL SYSTEM (b. Physical Condition)

Material	Physical Condition		
	Good Q = 3	Average Q = 2	Poor Q = 1
Structural Steel and Metal Decking	No weld cracks. No cracks at holes. No corrosion.	Few cracked welds (none critical). Few cracks at holes (none critical). Slight corrosion. Machine bolts.	Many cracked welds. Many cracks at holes. Moderate corrosion.
Concrete: Including Precast & Prestressed	Few minor shrinkage cracks. No shear or flexure cracks. No excessive deflection, (i.e., drift < story height divided by 240).	Few shear and/or flexure cracks (none critical). Few shrinkage cracks. Few cracked welds at precast connections.	Many shrinkage cracks. Many shear and flexure cracks. Deteriorated concrete. Exposed reinforcing. Excessive deflections in beams and slabs. Many cracked welds.
Masonry	Few minor shrinkage cracks. No shear or flexure cracks. Plumb walls.	Few moderate shrinkage cracks. Few shear or flexure cracks.	Many shrinkage cracks. Many shear and flexure cracks. Deteriorated, soft mortar. Exposed reinforcing. Bowed and out of plumb walls.
Timber and Plywood	No splits or twisted members. No loose bolts or screws. No loose knots. No projecting nails on bottom side. Grade worked lumber.	Few knots and splits, twisted members. Few loose bolts & screws. Minor-moderate deflections. Few loose nails. Fair nailing pattern. Fair connections.	Many splits and twisted members. Many loose bolts & screws. Rotting. Excessive deflections. Many loose nails.
Gypsum	No cracks in formboard. Good connection details. Smooth hand surface.	Few cracks in formboard. Crack pattern over T-supports.	Many cracks and excessive deflection of formboard.

TABLE 3.18 QUALITY RATING OF MATERIALS IN STRUCTURAL SYSTEM (c. Integrity)

Material	Workmanship		
	Good Q = 3	Average (Note A) Q = 2	Poor (Note A) Q = 1
Structural Steel	All parts of joints in full contact. Members straight. Structure plumb. Bolts tight. Structural welds all OK. Deck welds all OK. Continuous Inspection.	Few joints with members not in full contact. Few bent members. Few loose bolts. Few poor welds. Selective Inspection.	Many joints with members not in full contact. Many bent members. Many loose bolts. Many poor welds. No Inspection.
Concrete (Including Precast and Prestressed)	Clean construction joints. No rock pockets. Construction straight and plumb. All tendons grouted. Continuous inspection.	Few poor construction joints. Few small rock pockets. Few members show evidence of form failure. Few poor welds at precast joints. Tendons not grouted. Called inspection.	Many poor construction joints. Many rock pockets. Many evidences of form failure. Mixture of hardrock and lightweight concrete at joints. Many poor welds. No inspection.
Masonry	All grout and mortar spaces filled. Construction straight and plumb. Running bond. Continuous inspection.	Few grout and mortar spaces not filled. Running bond. Called inspection.	Many grout and mortar spaces not filled. Construction bowed and out of plumb. Stacked bond. No inspection.
Timber and Plywood	All members in full bearing contact at joints. Bolts & screws tight. Members straight & plumb. All plywood edges blocked with members 3"+ in width. Continuous inspection.	Few members not in full contact. Few loose bolts & screws. Few twisted or bowed members. Diagonal sheathing well nailed. Blocking by cleats and members 2"+ in width. Called inspection.	Many members not in full contact. Many loose bolts & screws. Many twisted and/or bowed members. Straight sheathing. Unblocked plywood. Irregular nail spacing & edge distance. No inspection.
Gypsum	Smooth hard surface. Continuous inspection.	Fair surface. Called inspection.	Rough, uneven surface. Soft material. No inspection.

TABLE 3.18 QUALITY RATING OF MATERIALS IN STRUCTURAL SYSTEM (d. Workmanship)

Material	Quality		
	Good Q = 3	Average Q = 2	Poor Q = 1
Structural Steel and Metal Decking	Ductile framing details. High strength bolts or good weld details to member. Approved tested deck systems properly welded and connected. Members well braced laterally. Decking welded for $\geq$ 1.0 K/LF in. shear.	Main connections are riveted or welded. Minor connections with unfinished bolts. Some members not adequately braced laterally. Decking welded for $\geq$ 0.5 K/LF in. shear.	Machine bolted connections. No lateral bracing of members. Deck diaphragm. <0.5 K/LF
Concrete: a. Poured in place b. Precast c. Prestressed	Close spacing of ties and stirrups. Ductile reinforced details. Spiral type columns. No precast or prestressed members.	Ordinary reinforced details tied columns. (#3 and over). Poured precast joinery well detailed w/welded reinforced precast & prestressed members.	Deficient framing details. No mild steel Deficient reinforced details tied columns (#2 & smaller). Welded precast joinery.
Masonry	Fully grouted members. Embedded anchors, bolts, & strap ties. Adequate reinforced, uniformly spaced in two directions. All columns filled. Adequate laps at corners and intersections. Adequate bars at openings.	Bolted connections. Adequate reinforced, concentrated at tops & bottoms of walls. Columns filled at reinforcing only. Horizontal mesh reinforced.	Non-grouted wall, nailed connection. No or partial reinforcement. Poor tie and lap details. Filler walls not anchored to framing.
Timber	Strap anchors to masonry walls plus shear transfer connections.	Melar hardware at some connections. Few steel strap ties at joints.	No connections to masonry walls. No strap at connections.
Plywood	Bolts at critical joints well anchored to footings. Steel strap ties to walls spaced 4 ft. or less.	Bolted & nailed joints anchored to footings. No strap ties or straps over 4 ft. o.c.	Not anchored to footings. No strap ties.
Gypsum	Trussed purlins. Adequate connection to walls. Mesh reinforced.	Solid purlins. Poor connections to walls.	No reinforcement. No connections to walls.

TABLE 3.19 QUALITY RATINGS FOR NONSTRUCTURAL COMPONENTS

Component	Quality		
	Good Q = 3	Average Q = 2	Poor Q = 1
Ceilings	Gypsum Board and MLP attached directly to structural framing (not suspended)	Suspended wood framing with Gypsum Board nailed Suspended Metal Lath and Plaster. Suspended Plywood nailed to wood framing.	Suspended "T" Bar with lay-in or splined acoustical tiles.
Partitions	Wood Panel, well anchored and braced to structure	Gypsum Board and Metal Studs and Plaster, anchored and braced to structure	Unreinforced masonry and Gypsum block. Ceiling height partitions, braced by suspended "T" bar ceilings.
Trim and Veneer	Not Applicable	Masonry Veneer and facings, well anchored and with cement mortar	Masonry Veneer on facings, not anchored and with poor mortar. Heavy ornamentation such as statues, steeples, and cornices.
Glass	Full elastomeric mounting with at least 1/2" clearance all around. Glass set outside of framing.	Elastomeric Mounting, 1/4" Clearance, set between framing.	Fixed sash with putty - negligible clearance
Filler Walls Between Framing Members	Reinforced Concrete or masonry wall anchored to frame. Metal and wood studs and plaster anchored to structure.	Unreinforced masonry cement mortar anchored to structural framing.	Unreinforced masonry, poor mortar. No anchorage to structural framing.

TABLE 3.19 QUALITY RATINGS FOR NON-STRUCTURAL COMPONENTS
(Continued)

Component	Quality		
	Good Q = 3	Average Q = 2	Poor Q = 1
Curtain walls set outside of framing line	Reinforced concrete and masonry well anchored to structure. Metal frame and siding well anchored. Struss well anchored.	Unreinforced masonry with good cement mortar. Anchored to structure. Precast concrete units - well anchored to structure.	Unreinforced masonry, poor mortar, not anchored to structure. Precast concrete units, welded anchorage.
Fire Escapes	Not Applicable.	Metal Framing attached to building.	Free standing concrete and masonry.
Overhangs and Gargoyles	Not Applicable.	Reinforced and anchored.	Unreinforced masonry, poorly anchored.
Signs and Marquees	Not Applicable.	Steel Frames. Signs on roof and walls.	Heavy marquees.
Antennae	Steel Towers Guyed.	Steel towers on roof not guyed.	Not Applicable.

The damage evaluation program uses the quality of the structure in two separate ways. First, as direct input to the computer program the user must specify the quality of each floor of the building. This quality factor only relates to nonstructural components and the values input are used in equation (3.4.64). Table 3.19 is presented so as to assist the user in the selection of nonstructural quality factors (note, one quality factor is input per floor). Since it is possible that different quality ratings may exist for each of the component types noted in tables 3.18 and 3.19 the user must average the ratings and obtain one rating value for each floor. The final floor rating need not be an integer. The second way in which building quality is utilized is indirectly through the selection of the drift to yield and the ductility to failure of the building's structural components. Table 3.18 is presented to assist in the establishment of the quality level of the structural system components. Later in this section it is shown how this latter quality is used to estimate drift to yield and ductility to failure. Therefore, in summary the quality factor for structural components is used to estimate drift to yield and ductility to failure.

Estimating Drift to Yield and Ductility to Failure

The estimation of structural damage using the methodology presented herein requires the user to input on a floor-by-floor basis his estimates of drift to yield, Δ_y, and ductility to failure, μ_f, for structural framing, shearwall members and floor diaphragms. To assist in this respect three professional engineers have presented their estimates of these values for various structural elements and quality factors. Tables 3.20 and 3.21 contain these estimates. It is apparent that the scatter among estimates by qualified professional engineers can be considerable. However, it is expected that the scatter would not be as great if attention were focused on one actual building.

If the engineer does not wish to use the guidelines presented in tables 3.20 and 3.21 he may (1) set values for the parameters based on his own professional judgment, or (2) attempt to find test results which provide parameter estimates for his particular problem, see [3.11]. To assist the engineer who wishes to utilize his own professional judgment the following comments are appropriate.

TABLE 3.20 JUDGED VALUES OF DRIFT TO YIELD (IN/IN) FOR VARIOUS QUALITY RATINGS

Function	Material	Δ_y - Drift to Yield											
		Good Q=3				Average Q=2				Poor Q=1			
		MO	JO	JA	Mean	MO	JO	JA	Mean	MO	JO	JA	Mean
Frame Member	Structural Steel	.010	.015	.013	.013	.005	.010	.009	.008	.002	.006	.004	.004
	Concrete: Poured in Place	.005	.010	.012	.009	.003	.006	.008	.006	.002	.003	.004	.003
	Precast Prestressed	.010	.004	.003	.006	.005	.002	.002	.003	.002	.001	.001	.001
	Timber	.020	.020	.005	.015	.010	.015	.003	.009	.005	.007	.002	.005
Shearwall	Concrete: Poured in Place	.002	-	.010	.006	.001	-	.007	.003	.001	-	.003	.002
	Precast Prestressed	.002	.004	.003	.003	.001	.002	.002	.002	.001	.001	.001	.001
	Masonry	.003	.007	.010	.007	.002	.005	.007	.005	.001	.003	.003	.002
Diaphragm	Metal Decking	.010	.010	.00[illegible]	.009	.005	.007	.004	.005	.002	.004	.002	.003
	Plywood	.010	.010	.008	.009	.005	.007	.006	.006	.002	.005	.003	.003
	Gypsum	NA	.004	.003	.004	NA	.002	.002	.002	NA	.001	.001	.001

MO - Donald Moran   JO - Roy Johnston   JA - Jack Janney   NA - Not Applicable

TABLE 3.21 JUDGED VALUES OF DUCTILITY FOR VARIOUS QUALITY RATINGS

Function	Material	μ_f - Ductility to Failure											
		Good Q=3				Average Q=2				Poor Q=1			
		MO	JO	JA	Mean	MO	JO	JA	Mean	MO	JO	JA	Mean
Frame - Member	Structural Steel	20	16	17	18	10	8	11	10	5	2	5	4
	Concrete: Poured in Place	10	8	13	10	5	4	9	6	2	2	4	3
	Precast Prestressed	NA	2	13	8	3	2	9	5	2	2	4	3
	Timber	10	8	14	11	5	4	9	6	3	2	5	3
Shearwall	Concrete: Poured in Place	5	4	11	7	3	3	7	4	1	2	4	2
	Precast Prestressed	NA	2	5	4	2	2	3	2	1	2	2	2
	Masonry	5	6	11	7	3	4	7	5	1	2	4	2
Diaphragm	Metal Decking	15	8	11	11	8	6	7	7	3	2	4	3
	Plywood	10	6	14	10	5	4	9	6	3	2	5	3
	Gypsum	5	4	8	6	3	3	5	4	2	2	3	2

MO - Donald Moran JO - Roy Johnston JA - Jack Janney NA - Not Applicable

The load deflection characteristics of simple steel and/or concrete elements is reasonably well understood. For example, figure 3.50 shows a typical load deflection curve for structural beams and beam-columns. In each case the shape of the curve is basically the same. The question to be answered is what values of drift to yield and ductility to failure can be inferred from data of this type and observed building response during earthquakes? Two alternate approaches to answering this question appear to be appropriate. Prior to discussing these approaches, it is to be noted that since there have never been _any_ detailed measurements of interstory drift for buildings subjected to severe earthquakes, no method can be stated as best.

One approach to specifying drift to yield during earthquake response is to relate the drift to SEAOC recommended design drift levels [3.6]. In particular, the recommended design drift limitation is 0.005. The basic notion now is to use one's professional experience to specify what multiple of this 0.005 value corresponds to a drift at which story yielding occurs. One may use a multiplication factor of unity but any design engineer knows that many factors of safety exist and the factor should be greater than unity. A complete study of the San Fernando building response data is not yet complete. However, it was observed that building response exceeded code design base shears by up to two without any observable damage. One could infer from this that it is possible to exceed the 0.005 drift by approximately a multiple of two and not experience damage. In fact, the judged factors in table 3.20 indicate such thinking. Therefore, one approach which could be followed is to relate ones estimate of yield drift levels to design drift levels.

A second approach to estimating drift to yield involves conducting an analytical study of one of the building stories. This study should be consistent with the analytical modeling assumptions which were discussed in section 3.4E. That is, if a story stiffness model is used then only column stiffness should be considered and drift to yield should correspond to beam-column, shear wall, a braced frame, etc, values. However, if the detailed analytical building model is used then a more refined story model is appropriate. Axial shortening and joint rotation should be included. One approach to analytically modeling such a story drift to yield relates to common laboratory modeling techniques. That is, if the frame is a rectangular moment resisting frame then column mid-height inflection points allow a no moment assumption to be made. Then, detailed linear or nonlinear stiffness matrices may be used to calculate the force deflection behavior of that floor level. Nonlinear force deflection relationship of the type shown in figure 3.50 are examples. From this data one can then estimate story drift to yield by systematically using component forces-deflection relationships.

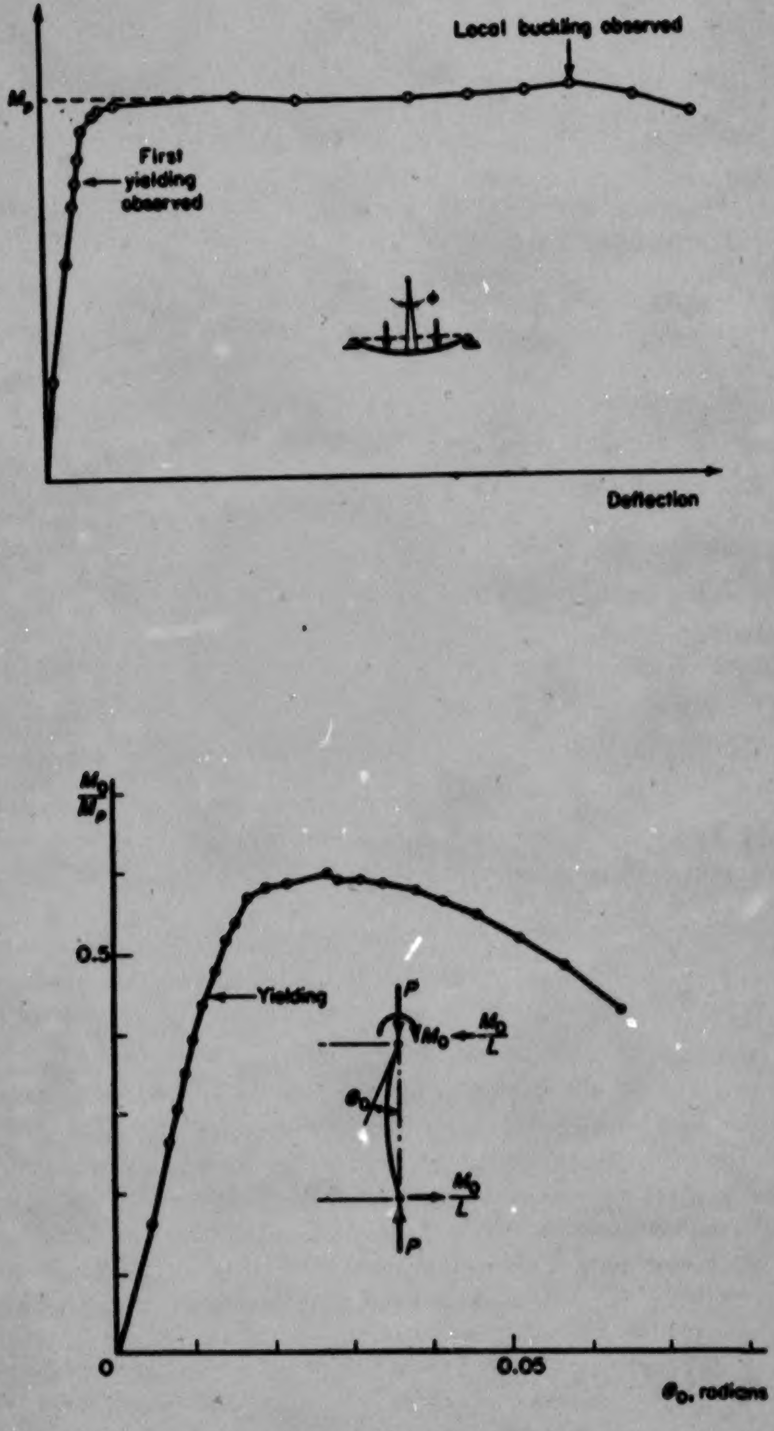


Figure 3.50 Typical Load Deflection Curves for Steel Members

Which option is correct? The approach recommended herein is to do an analytical study utilizing laboratory component test results where possible and then compare the calculated drift to yield with experience and the latest laboratory test results.

Comments on Estimating Coefficient of Variations for Input to Computer Program

This section presented three damage evaluation equations, (3.4.62), (3.4.64) and (3.4.66). Two of the equations (3.4.62) and (3.4.66) involved a coefficient of variation. The user must input to the program his estimated value of these coefficients of variation. The mathematical definition of this statistical term is straight-forward, see equation (3.4.57), and the user may use the definition to estimate the coefficient. Alternately, table 3.23 expresses the coefficient of variation is a percentage of the mean for three categories of confidence.

Table 3.22 GUIDELINES FOR UNCERTAINTY QUANTIFICATION

Level of Confidence	Coefficient of Variations as a Percent
excellent	below 5
fair	5 to 25
poor	above 25

An alternate way of quantifying this coefficient is presented in table 3.23. Therein ninety-five percent confidence range about the mean is related to the coefficient of variation. Consider for example the case where one is ninety-five percent confident that the true value of the parameter (always unknown) is between plus or minus twenty percent of the mean. It then follows that the coefficient of variation is 0.10. The numerical relationship given in this table is based upon a normal probability density function and if an alternate distribution is more appropriate a corresponding table follows directly.

Table 3.23 CONFIDENCE RANGE AND UNCERTAINTY QUANTIFICATION

Ninety Five Percent Confidence Interval about the Mean (Percent)	Coefficient of Variation as a Percent
± 10	5
± 20	10
± 30	15
± 40	20
± 50	25
± 100	50

H. WIND, TORNADO AND HURRICANE DAMAGE EVALUATION METHODOLOGIES

The damage experienced by a building during strong winds is estimated from the building interstory displacements and floor level wind pressures. The former response parameter is used to estimate structural and partition damage whereas the latter parameter is used to estimate window damage. Failure of walls due to normal pressure loading and glass breakage due to interstory drift are not considered to be significant failure modes.

Wind damage is estimated on a floor-by-floor basis and varies from zero to one hundred percent for each damage category. Analogous to the earthquake structural damage algorithm, an S-shaped curve is used to define damage variations about a mean damage value.

Tornado and hurricane damage is evaluated using the same procedure as employed for strong winds. The only difference is that instead of obtaining a site wind velocity directly from Thom's maps, see section 3.4C, the user must specify a tornado or hurricane wind velocity. To assist in the selection of such a velocity magnitude, section 3.4D provided guidelines.

Structural Damage

The ductility associated with a particular building floor is obtained by dividing the floor interstory displacement by the floor drift to yield. As discussed in section 3.4G, the drift to yield is established by the user and depends upon the quality of the building. The damage associated with the calculated ductility is obtained using an S-shaped curve identical in shape to that used in the earthquake damage algorithm. In particular, the percent damage is calculated as shown in figure 3.51 with 50% damage corresponding to $\mu_f = 1$.

A dispersion parameter is used to characterize the steepness of the curve and it is noted that this coefficient of variation or dispersion parameter, C_{vy}, is in general much smaller for wind than for seismic analysis. The selection of a value for this coefficient can be done using table 3.22 While for the earthquake problem the coefficient of variation represents the scatter in μ_c which is a function of the variables μ_f, magnitude, period and quality, in the wind analysis the scatter only depends upon the drifts to yield, i.e., Δ_y.

The wind response of a building differs from the earthquake response in the sense that the duration of strong wind loading is usually orders of magnitude greater than the earthquake strong motion. Therefore, in the development of the damage algorithm, the conservative approach taken in the wind problem assumes that if the wind response is large enough to induce yielding then the component will always have a sufficient number of cycles of motion to cause the cumulative cyclic yielding to reach to components failure level, see figure 3.47. This implies that the μ_c for wind is unity, or 50% damage at $\mu = 1$.

The equation for the percent structural damage corresponding to wind loading is written in terms of the calculated interstory drift at the ith floor, $(\Delta)_i$, and the user input interstory drift to yield, $(\Delta_y)_i$, i.e.,

$$\begin{bmatrix}\text{Percent Structural Damage} \\ \text{(ith floor)}\end{bmatrix} =$$

$$\frac{100}{\sqrt{2\pi}\,(\Delta_y)_i(C_{vy})_i}\int_0^{(\Delta)_i} \exp\left\{-\frac{1}{2}\left[\frac{Z-(\Delta_y)_i}{(\Delta_y)_i(C_{vy})_i}\right]^2\right\}dZ \qquad (3.4.67)$$

Nonstructural Damage - Partitions

The partition damage during strong winds, tornados or hurricanes is estimated in the same manner as the structural damage. The only difference is in the numerical values of the input interstory drifts to yield. Therefore, equation (3.4.67) is again used but with $(\Delta_y)_i$ and (C_{vy}) being the drift to yield and the coefficient of variation for partitions.

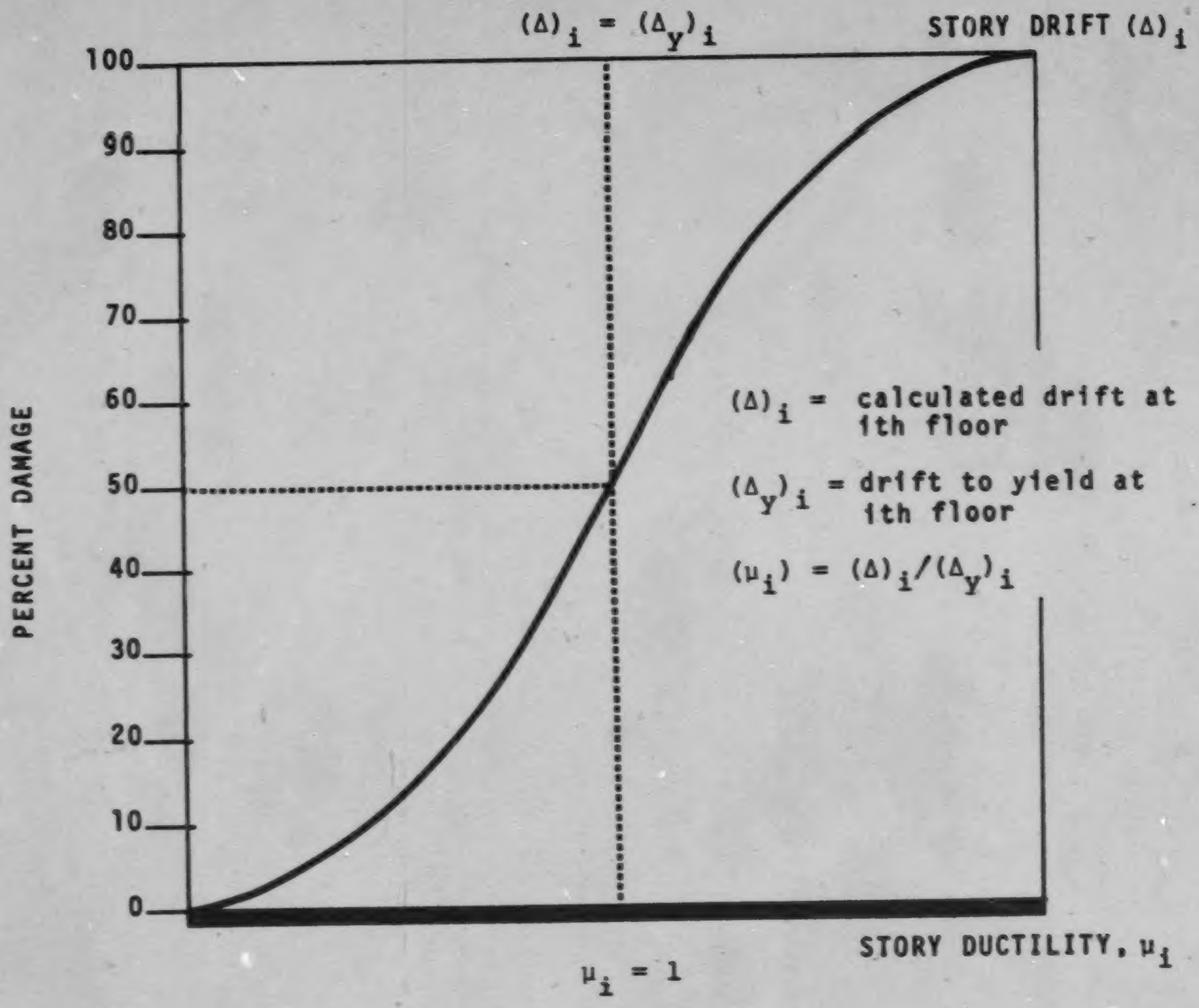


Figure 3.51 Structural Damage Versus Ductility

Nonstructural Damage - Windows

The percent of windows which break at a particular floor depends upon the wind pressure at the floor level plus the window's physical parameters. In particular the pressure required to break a window in flexure is (see [3.60])

$$p_o = \text{breakage pressure} = \frac{\alpha_G t^2 \left[1 + 1.61 \left(a^3/c^3\right)\right]}{0.75a^2} \qquad (3.4.68)$$

where

σ_G = mean breaking stress of glass (lb/in^2)

a = minimum glass dimension, either h or b (in)

c = maximum glass dimension, either h or b (in)

b = average window width (in)

h = average window height (in)

t = glass thickness (in)

Analogous to the structural and partition damage an S-shaped curve is used to evaluate the percent damage. The fifty percent damage level is at a window pressure equal to p_o and a coefficient of variation or dispersion coefficient, C_{vG}, is input by the user.

The equation for the percent window breakage at the ith building floor is:

$$\begin{bmatrix}\text{Percent of Windows Broken} \\ \text{(ith floor)}\end{bmatrix} =$$

$$\frac{100}{\sqrt{2\pi}\,(p_o)_i (C_{vG})_i} \int_0^p \exp\left\{-\frac{1}{2}\left[\frac{Z - (p_o)_i}{(p_o)_i (C_{vG})_i}\right]^2\right\} dZ \qquad (3.4.69)$$

where

p = wind pressure (lbs/in^2)

In calculating $(p_o)_i$ for the ith floor the average values of the glass parameters for that floor are used in equation (3.4.68). The computer program estimates the percentage of corner windows damaged using corner pressure values and the percentage of non-corner window damage using the corresponding pressure values.

I. LONG SPAN ROOF DAMAGE EVALUATION

General Comments

Before beginning this part of the study, roof damage information of a statistical nature was gathered in order to determine the critical parameters which affect failure. C. Wayne Parish, President of Haag Engineering Co. of Dallas, Texas and Jack Janney of Wiss, Janney, Elstner and Associates of Northbrook, Illinois searched their extensive files and completed forms of the type shown in figures 3.52 and 3.53. Both of these companies have extensive experience in damage inspection and evaluation for insurance companies and other organizations who require a high level diagnosis of failure causes.

Table 3.24 describes roof failures due to severe wind. The following conclusions are made:

- Roof peeling is by far the primary mode of failure.
- Roofs collapse in winds, primarily due to water ponding from debris clogging the drains, or wall failure.
- Structural members of the roofing system rarely fail, and then only moderately under severe (200+ mph) winds.
- Roof fly-off is rare.

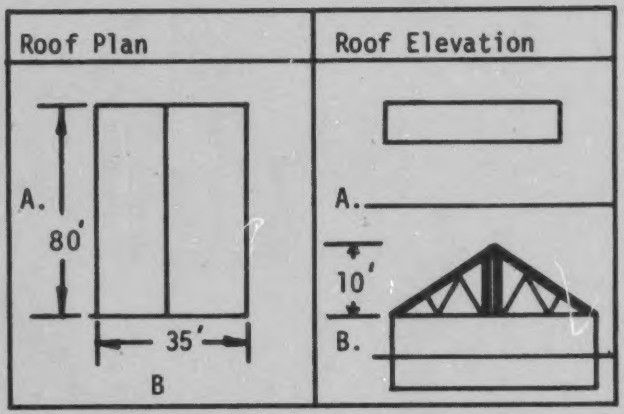
Methodology

In evaluating the damageability in this case, the methodology assumes that the roof will:

- fly off due to uplift, or
- collapse due to ponding.

Failure by wall collapse due to interstory drift would be automatically accounted for in the structural damage portion of the program. Also, the possible peeling of the roof covering is not considered since it does not cause a major financial loss or a potential loss to life.

Of special modeling consideration is the roof where uplift may cause a serious failure. The determination of the probable risk associated with such a failure is highly dependent upon roof connection details. Therefore, the computer program creates an uplift model for roof risk evaluation. This model, admittedly simple, assumes that the roof is infinitely rigid and sums the capacity of all the connection elements which restrain the roof from uplift. This total vertical resistive force is then compared with the uplift forces on the roof and the computer program calculates whether or not the roof could fly off.



Betsy Case # 3

A. MATERIAL TYPE

Truss 2 x 8 Wood Truss

Decking 1 x 8

Roofing Composition Shingles

B. FAILURE MODE*

(1) Roofing only peels off

estimate 5 % of roofing

(2) Roofing & decking peels off

estimate ______ % of roofing & decking

(3) Local truss members fails

estimate ______ % of members

(4) Local truss joint failure

estimate ______ % of joints

(5) Entire system flies off

estimate ______ % of connections failed

C. DAMAGE ESTIMATE TO BUILDING & CONTENTS

90% $\left(\frac{\text{Repair \& replacement cost}}{\text{Present worth}}\right)$

Roof pretty much in tact. Walls caved in on windward side.

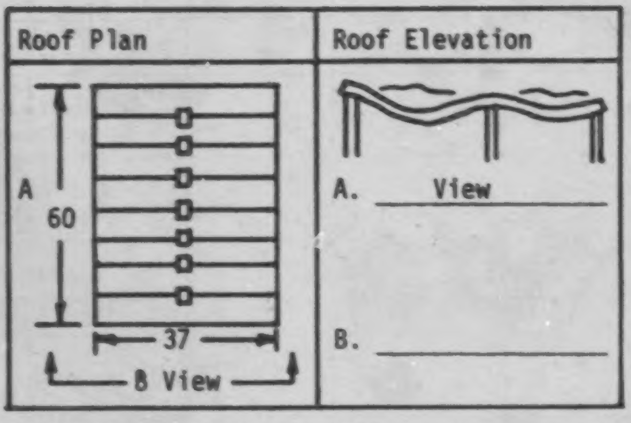
D. MAXIMUM WIND VELOCITY ESTIMATE

110 MPH Gusts to 160

E. RAIN ASSOCIATED WITH B-3 & 4?

yes ✓ no ______

Figure 3.52 Sample Survey of Roof Failure



Beaulah Case # 2

A. MATERIAL TYPE

Decking 1 x 12 Laminated Wood Beam

Roofing Asphalt, felt and gravel

B. FAILURE MODE* - debris stopped up drains, water accumulation collapsed roof

(1) Roofing only peel off

estimate ________ % of roofing

(2) Roofing and decking peels off

estimate ________ % of roofing & decking

(3) Local web failure

estimate ________ % of frame repair

(4) Local flange failure

estimate ________ % of frame repair

(5) Entire system flies off

estimate ________ % of connections fail

C. DAMAGE ESTIMATE TO BUILDING & CONTENTS

100 % $\left(\frac{\text{Repair \& replacement cost}}{\text{Present worth}}\right)$

D. MAXIMUM WIND VELOCITY ESTIMATE

80 MPH Gusts to 120

E. RAIN ASSOCIATED WITH B-3 & 4

yes ✓ no ________

Figure 3.53 Sample Survey of Roof Failure

Table 3.24 ROOF DAMAGE SURVEY RESULTS

Case No.	Roof Type	Plan Dimensions (ft)	Span Support To Support (ft)	Wind Velocity (mph)	Roof Failure Type	Roof Damage By Type (%)	Remarks
1	Lamella Dome	?	?	60+gusts	Roofing peeling	1	Severe water damage
2	Laminated Wood Beam	60 x 37	19	80-120	Collapse due to water ponding	100	Debris stopped up drains, causing ponding. Hurricane Beulah
3	Wood Truss	35 x 80	35	110-160	Roofing peeling	5	Walls caved in on windward side, roof intact, 90% damage to structure
4	Wood Truss	60 x ?	60	80-120	None	100	Wall collapse due to tide, Hurricane Beulah
5	Wood Truss	90 x 120	23	80-120	Roofing & decking peeling	10	5% damage to structure
6	Steel Truss	70 x 110	70	160	Roofing & decking peeling	60	50% damage to structure
7	Steel Truss	90 x 150	90	160	Roofing & decking peeled off	100	60% damage to structure
8	Wood Beams	60 x 120	20	80-120	None	0	Water accum. sagged roof
9	Concrete	?	?	40-60	Roofing peeling	75	Less than 1%
10	Bar Joist	85 x 140	?	60	Roofing & decking peeling	Roof Deck 35 15	
11	Precast, Prestressed Gull Wing Tees	70 x 160	70	200	Some beam failure	6	100% damage due to window breakage, destroyed contents
13	Precast, Concrete Slabs	80 x 80	8	75	Roofing only peeling off	25	

Collapse due to ponding is simply treated by requiring the user (1) to estimate the total depth of ponding that can occur per vertical load carrying member (e.g., truss spacing), (2) to state whether or not rain accompanies the wind, (3) to judge the quality rating of the roof in relationship to the code loads that should be resisted by the design, and (4) to define the dead load per vertical load carrying member. The program then simply computes whether or not the roof could collapse due to wind-driven rain ponding on the roof. Guidance on the effect of roof flexibility on the depth of ponding is given in Ref. [3.63].

Quality Rating Techniques

The evaluation of long span roof systems is based on the premise that the structure was originally designed according to the requirements of the governing building codes. If the structure does not appear to be seriously deficient when visually surveyed, it should be assumed to have been adequately designed. The capacity of the structure to carry the design code loads should then be assumed sufficient.

The evaluation of the structure should point out any major deficiencies in the original design, and it should give a survey of the present condition of the structure. The major portion of the evaluation will be a field examination of the building with some office calculations to check the elements that seem to be lacking in strength. Some of the more important items that should be evaluated are described in the following paragraphs for wood, steel, and concrete long span roofs. The following points refer to a good, Q=3, quality roof design.

- Wood trusses:

  Wood trusses are common load carrying members for long span roofs. If the following items appear to conform to code design requirements, the truss should be able to easily carry the design vertical loads with an appropriate factor of safety:

  (a) The wood members should be sound and free from weakening cracks.

  (b) The connections should not appear to have been overloaded by showing signs of slipping or having bearing failures.

  (c) The chord members should be adequately braced perpendicular to the plane of the truss by struts or bracing to keep the chords in line.

  (d) The bolts should be tight.

  (e) The connections to the columns or walls should appear free from movement or distress.

  (f) The truss should not have excessive sag.

- **Steel Trusses and Girders:**

  Steel trusses and girders are common load carrying members for long span roofs when properly designed and detailed. The following items should be checked to evaluate the condition of the steel truss or girder:

  (a) The elements should be sound, straight, and free from visual damage.

  (b) The bolted connections should be tight.

  (c) The chords of the truss or flanges of the girder should be stayed properly by either bracing or struts perpendicular to the plane of the truss or girder.

  (d) The connections to the columns or walls should appear to have had no movement or distress.

- **Concrete and Wood Arches:**

  Concrete and glue laminated wood arches are not a common load carrying member for long span roofs, but there are some throughout the country and should be evaluated for the following items:

  (a) The members should be free from visual damage or overstress.

  (b) The supports should appear solid and free from lateral movement.

  (c) A solid buttress or tie rod is required for the horizontal forces at the heel of the arch.

- **Concrete and Wood Girders:**

  Concrete girders may be either of the typical reinforced type or of the prestressed or post-tensioned type. Wood girders for long spans are usually glue laminated straight or cambered members. These girders need to be evaluated for the following two items:

  (a) The members should be free from visual damage.

  (b) The connections to the walls or columns should be free from signs of overstress or movement.

The quality rating factors used in section 3.4G can be used to degrade the capacity of the structural systems described above in the same proportions as estimated in table 3.19 for Structural Systems. The judged degradation values for the various Q values are listed below and are only given as guidelines:

Q	Vertical uplift load capacity	Vertical downward load capacity
3	1.5 x code	1.5 x code
2	1.0 x code	1.0 x code
1	0.5 x code	0.5 x code

Description of Damage Evaluation Procedure

- Uplift: The user has 3 options as to the specifications of uplift forces.

  Option A: Forces calculated under option A make use of internally stored pressure coefficients for symmetrical gabled roofs assuming a zero wind angle. The pressure coefficients are formed after the general specifications of the Swiss Building Code [3.35], see table 3.25.

  User Input: a) angle of roof, α, (degrees) b) total vertical load capacity (dead load + connection resistance)

  Output: program compares roof forces calculated internally with user input AND determines whether roof is ON or OFF.

  Option B: Forces calculated under option B again make use of internally stored pressure coefficients for symmetrical roofs with a zero wind angle. The pressure coefficients are formed after the general specifications of the ANSI-A58-1972 standard [3.2] table 3.26.

  User Input: Same as Option A

  Output: Same as Option A

  Option C: If the user desires a more detailed approach, he is given the option of specifying pressure coefficients for the individual building. An example of such a specification is shown in Figure 3.54 as derived from the Swiss Wind Tunnel Tests [3.35]. The user must bear in mind that the coefficients shown apply only to buildings with the shape and configurations designated.

  User Input: Same as Option A plus a vector of the pressure coefficients shown in the figures

  Output: Same as Options A & B

- Collapse: The user estimates the dead load of the roof including frame. The user estimates the mean depth in feet of ponding that could occur if all drains are plugged. The computer program computes total water load, adds it to the dead load and compares it to the downward vertical load carrying capacity related to code which is specified by the user. If the former loads exceed the latter capacity then the roof collapses.

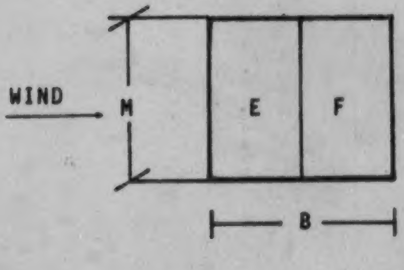
Table 3.25 GENERAL SPECIFICATIONS FROM SWISS CODE FOR CLOSED BUILDINGS WITH RECTANGULAR PLAN, WIND DIRECTION=0°

$2/5 \leq L/B \leq 5/2$

$2/3 \leq B/M \leq 3/2$

	Windward Slope (E)		
	$0° \leq \alpha \leq 20°$	$20° \leq \alpha \leq 50°$	$50° \leq \alpha \leq 85°$
Pressure Coefficient	-1.0	$\frac{(5\alpha - 200)}{100}$	$\frac{\alpha}{100}$

	Leeward Slope (F)
	$0° < \alpha < 85°$
Pressure Coefficient	-0.7



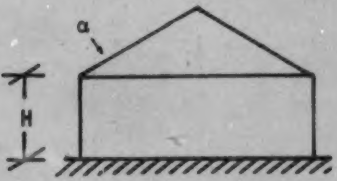


Table 3.26 ANSI A58.1 - 1972 [3.2] EXTERNAL PRESSURE COEFFICIENTS FOR ROOFS

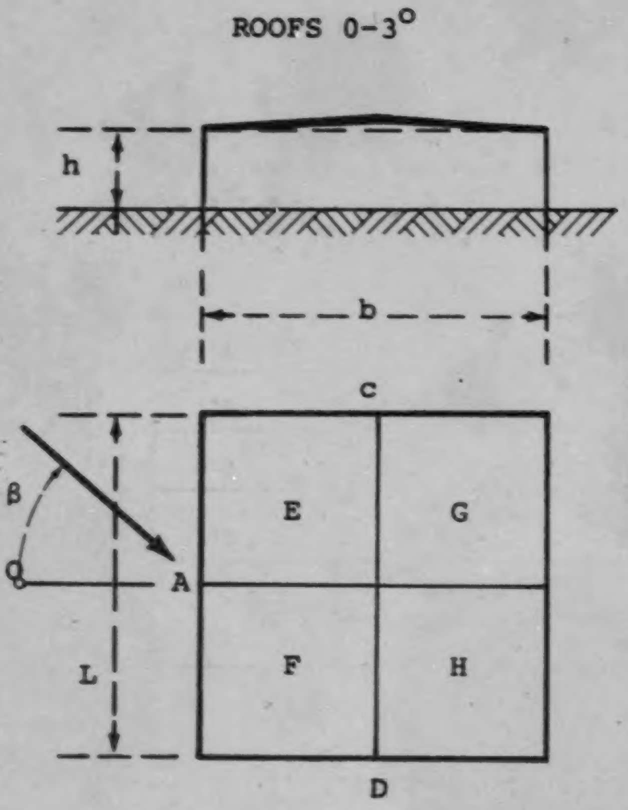
	Windward Slope								
H/w	10° - 15°	20°	25°	30°	35°	40°	45°	50°	≥ 60°
≤0.3	.010*	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.010
0.5	-1.0	-0.75	-0.5	-0.2	0.05	0.3	0.45	0.5	0.010
1.0	-1.0	-1.0	-0.8	-0.55	-0.3	-0.05	0.2	0.45	0.010
>1.5	-1.0	-1.0	-1.0	-0.9	-0.6	-0.35	-0.1	0.2	0.010

*if H/w = 0 then use c_p = -1.0

Leeward Slope - c_p = -0.7

w = least building width (either B or H)

H = building height



EXT PRESS COEF Cpa FOR h:b:l=1:4:4

β	A	B	C	D	E	F	G	H
0°	+0.9	-0.3	-0.4	-0.4	-0.8	-0.8	-0.3	-0.3
45°	+0.5	-0.4	+0.5	-0.4	-0.9	-0.6	-0.6	-0.3
90°	-0.4	-0.4	-0.9	-0.3	-0.8	-0.3	-0.8	-0.3

Figure 3.54 Example of Uplift Forces for Various Types of Roofs and Wind Directions [3.40]

4. DEMONSTRATION OF HAZARD EVALUATION METHODOLOGY

4.1 INTRODUCTION

This chapter presents the damage evaluation analysis of a two-story building using each of the three evaluation methods described in chapter 3. Additional examples demonstrating the use of the three methods are presented in Appendix D.

The building is a reinforced concrete office building. Roof and floor systems utilize reinforced concrete joists and girders and lateral force resisting elements consist of concrete shear walls which are non-loadbearing. The building has a complete vertical load-carrying concrete frame. The thin, architectural precast concrete panels with exposed aggregate are a veneer and were used as a form for the poured concrete walls. The anchorage of these panels is considered to be excellent. The results of the damage evaluation obtained using the three methods are presented in section 4.6.

4.2 DATA COLLECTION FORM (DC FORM)

The data collection form which are completed for this building are given in this section. The information in DC Form is used for the Field Evaluation Method and the Approximate Analytical Method.

DC-1

DATA COLLECTION FORM
NATURAL HAZARDS EFFECTS
(Extreme Winds, Earthquakes)

A. GENERAL DATA

*1. Facility No. R.C. BUILDING 2. Building Name ____

3. Address — 4. City —

5. State — 6. Zip Code — 7. Year Built —

8. Date of Major Modifications or Additions, if any —

9. Building Code Jurisdiction: City ☑ County ☐ State ☐ Federal ☐

*10. Latitude — *11. Longitude —

12. Current Bldg. Use OFFICE Orig. Bldg. Use SAME

13. Basement Yes ✓ No ____ Number of Basements 1

No. of Stories Above Basement 2 (See also Item A23)

14. Height of First Story 14'-0" ft.

15. Upper Story Height 14'-0" ft. Special Story Height NONE ft.

16. Is the exterior of first story different from upper stories?

Street Front Side Yes ____ No ✓ Other Sides Yes ____ No ✓

17. Approximate Roof Overhang Distance 1'-0" Side ALL SIDES

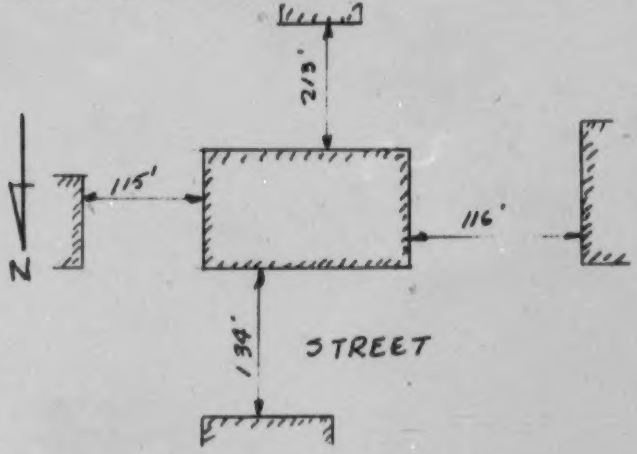
18. Proximity to Adjacent Buildings: Sketch Below with North Arrow

North Side 134' South Side 213' East Side 115' West Side 116'

Note Street or Alley Sides STREET ON NORTH

*To be filled in by Field Supervisor.

Sketch



19. Are plans available? YES If so, where obtainable ARCHITECT

Are original calculations available? YES If so,

where obtainable ENGINEER

Name of: Architect — Engineer —

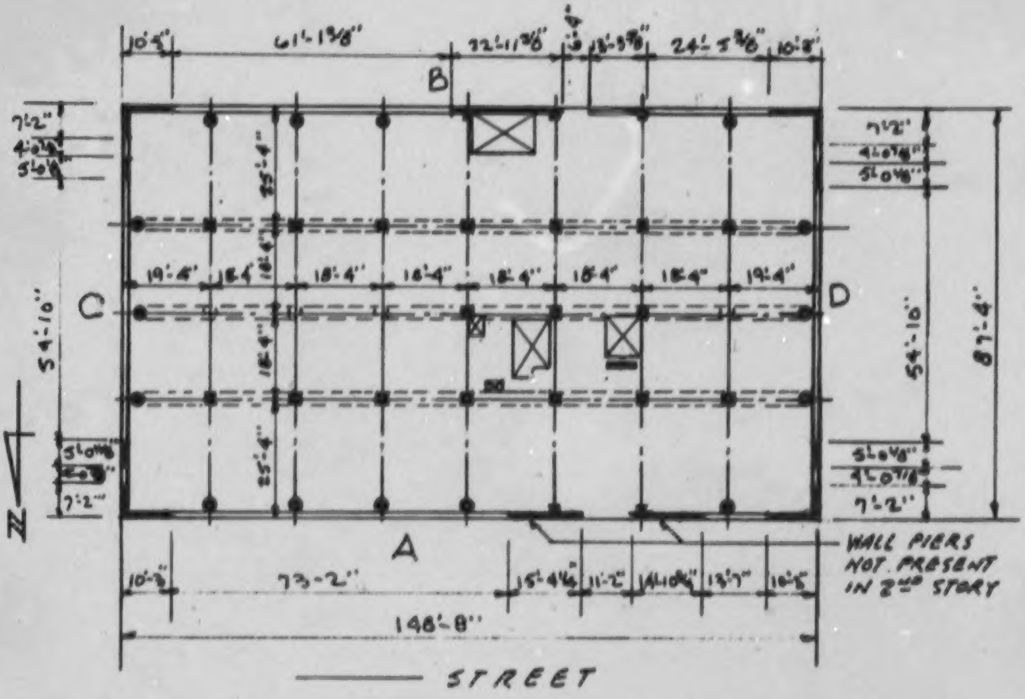
Contractor —

Regulatory Agency CITY

20. Basic Building Plan

a. Sketch overall plan.
b. Locate shear walls, if any.
c. Locate main frames.
d. Locate expansion joints, if any.
e. Give approximate north arrow and label sides "A", "B", "C", "D", etc. Show street or alley sides.
f. Note any common or party walls.
g. If plan changes in upper floors, sketch this plan and note level of change.

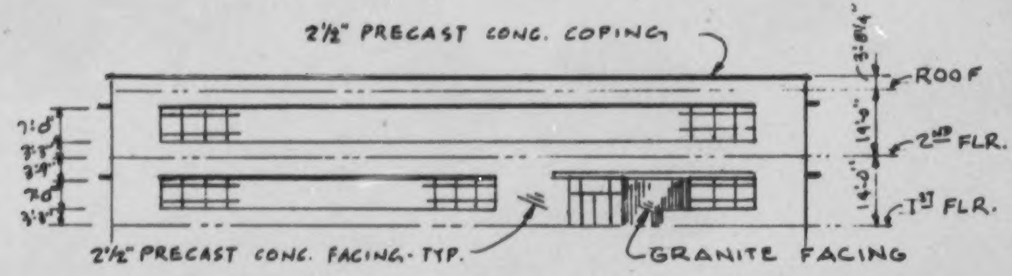
(Use additional sheet if necessary)


10'-5"
61'-1 3/8"
32'-11 3/8"
13'-5 3/8"
24'-5 3/8"
10'-8"
B
7'-2"
4'-0 7/8"
5'-0 7/8"
25'-4"
18'-4"
19'-4"
18'-4"
18'-4"
18'-4"
18'-4"
18'-4"
18'-4"
19'-4"
C
D
54'-10"
54'-10"
87'-4"
18'-4"
25'-4"
5'-0 7/8"
4'-0 7/8"
7'-2"
N
A
10'-3"
73'-2"
15'-4 1/4"
11'-2"
14'-10 3/4"
13'-7"
10'-5"
148'-8"
WALL PIERS NOT PRESENT IN 2ND STORY
STREET

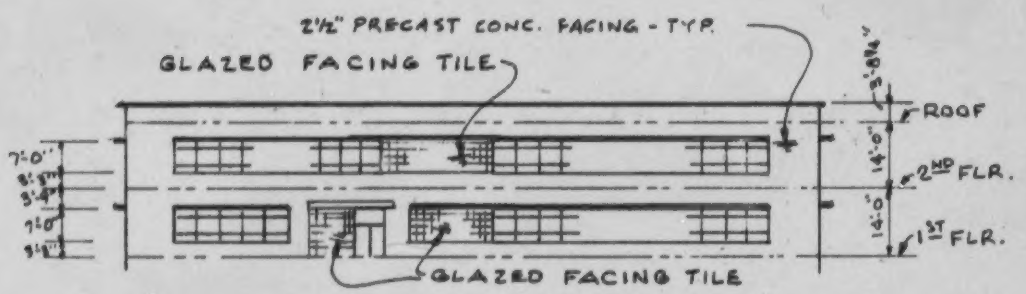
21. Elevation of Exterior Walls.

Sketch:
- a. All openings or note pattern of openings.
- b. Note exterior finish and appendages.
- c. Note material of walls.
- d. Major cracks or other damage. (Note if cracks are larger at one end.)
- e. Note previously repaired damage.
- f. Note any evidence of damage to cladding or appendages.

(Use additional sheet if necessary)

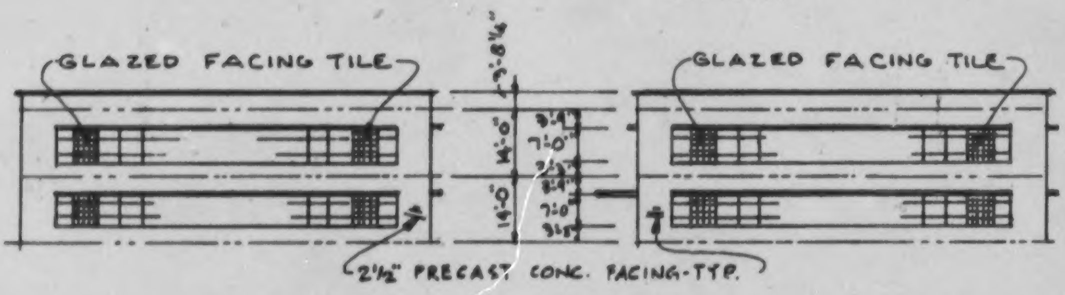

2½" PRECAST CONC. COPING
3'-8¼"
ROOF
14'-0"
2ND FLR.
14'-0"
1ST FLR.
7'-0"
3'-3"
3'-4"
7'-0"
3'-3"
2½" PRECAST CONC. FACING-TYP.
GRANITE FACING

WALL A


2½" PRECAST CONC. FACING-TYP.
GLAZED FACING TILE
3'-8¼"
ROOF
14'-0"
2ND FLR.
14'-0"
1ST FLR.
7'-0"
3'-3"
3'-4"
7'-0"
3'-3"
GLAZED FACING TILE

WALL B

NOTE: EXTERIOR WALL MATERIAL IS CONCRETE TYPICAL.


GLAZED FACING TILE
3'-8¼"
14'-0"
14'-0"
3'-4"
7'-0"
3'-3"
3'-4"
7'-0"
3'-3"
GLAZED FACING TILE
2½" PRECAST CONC. FACING-TYP.

WALL C

WALL D

241

22. Elevation of Interior Shear Walls. NONE

Sketch: a. All openings.
b. Major cracks or other damage. (Note if cracks are larger at one end.)
c. Note any previously repaired damage.

23. Adaptability of Basement to Storm Shelter.

a. Floor Over Basement - Concrete ☑ Other ☐

b. If concrete, give thickness JOIST & SLAB - 12" JST + 3" SLAB

c. Available Space (approximate) 9,500 sq. ft.

d. Dangerous Contents. Storage of Flammable Liquids ☐

Presence of Transformers or Other Dangerous Equipment ☐

Other Hazards ______________________________

None ☑

24. Is this a Vault-like Structure? Yes ☐ No ☑

25. EXTERIOR WALL SUMMARY SHEET

Exterior Characteristics	Side A	Side B	Side C	Side D
Extensive Architectural Ornaments or Veneer	✓	✓	✓	✓
WALLS				
Metal Curtain Wall				
Precast Concrete Curtain Wall				
Stone				
Brick				
Concrete Block				
Concrete	✓	✓	✓	✓
Other				
For Concrete Block and Brick, indicate R for Running Bond S for Stacked Bond				
Condition of Wall*				
OPENINGS				
Percent of Open Area per Story	2nd = 43% 1st = 35%	2nd = 35% 1st = 32%	2nd = 36% 1st = 36%	2nd = 36% 1st = 36%

*1. No cracks, good mortar.
2. Few visible cracks.
3. Many cracks
4. Evidence of minor repairs.
5. Evidence of many repairs.

B. SITE RELATED INFORMATION

1. Exposure

a. Centers of large city ☐ b. Very rough hilly terrain ☐

c. Suburban areas, towns, city outskirts, wood areas, or rolling terrain ☐ d. Flat, open country ☑

e. Flat coastal belts ☐ f. Other ☐

2. Topography

a. Building on level ground ☑ b. Building on sloping ground ☐

c. Building located adjacent to embankment ☐

*3. Geologic formation —

*4. Location of known faults: Name — Miles —

Miles ____

*5. Depth of water table — ft. When measured: — (Month) — (Year)

*6. Depth of bedrock — ft.

*7. Soil type — — —

*8. Bearing capacity — p.s.f., or — blows per inch

9. Proximity to potential wind-blown debris - Type LUMBER YARD

Location ____ Distance 400'

---

*To be filled in by Field Supervisor.

C. STRUCTURAL SYSTEMS

1. Material

Concrete ☑ Masonry ☐ Steel ☐ Wood ☐

2. Vertical Load Resisting System

Frame ☑ Bearing Wall ☐ Wall and Pilasters ☐

For frame system, check one for typical column cross-section

□	○	▭	H	Other
☑	☐	☐	☐	☐

3. Lateral Load Resisting System

Masonry Shear Wall ☐

Concrete Shear Wall ☑

Plywood Shear Wall ☐

Braced Frame ☐

Moment Resisting Frame ☐

Are resisting systems symmetrically located? ☑ Yes LOWER STORY ☑ No UPPER STORY

4. Floor System

Frame

Concrete Beams ☑

Steel Beams ☐

Steel Bar Joist ☐

Wood Beams ☐

No Framing Members ☐

Precast Concrete Beams ☐

Deck

Concrete Flat Plate ☐

Concrete Flat Slab ☐

Concrete Waffle Slab ☐

Steel Deck ☐

Wood Joists ☐

Wood Plank ☐

Straight Sheathing ☐

Plywood Sheathing ☐

Diagonal Sheathing ☐

Precast Concrete Deck ☐

Concrete Joists ☑

Concrete Plank ☐

Note if concrete topping slab is used over metal decks or concrete plank.

Connection Details

	Framing	Decking To Framing
Bolted	☐	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Floor to Walls

Type REINFORCING BARS

Spacing 3'± NORTH & SOUTH WALLS — 18" o.c. EAST & WEST WALLS

5. Roof System

Frame

Concrete Beams	☑	Steel Truss	☐
Steel Beams	☐	Wood Truss	☐
Steel Bar Joist	☐	No Framing Members	☐
Wood Beams	☐	Precast Concrete Beams or Tees	☐
Wood Rafters	☐		

Deck

Concrete Flat Slab	☐	Concrete Waffle Slab	☐
Metal Decking	☐	Plywood Sheathing	☐
Concrete Slab	☐	Diagonal Sheathing	☐
Concrete Joists	☑	Straight Sheathing	☐
Precast Decking	☐	Concrete Fill	Yes ☐ No ☑

Connection Details

	Framing	Docking to Framing
Bolted	☐	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Roof to Walls

Type REINFORCING BARS

Spacing 3'T NORTH & SOUTH WALLS – 18"OC. EAST & WEST WALLS

D. NONSTRUCTURAL ELEMENTS

1. Partitions

Type

	Typical	Corridor
Partial Height	☐	☐
Full Height Floor-To-Ceiling	☐	☐
Floor To Floor	☑	☑
Movable	☐	☐

Composition

Lath and Plaster ☑ - STEEL STUDS

Gypsum Wallboard ☐

Concrete Block ☐

Clay Tile ☐

Metal Partitions ☐

2. **Ceiling**

Typical Room

Material

Acoustical Tile ☑ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☑ Metal Channels ☐ Tee Bar Grid ☑

Attached Directly to Structural Elements ☐

Typical Corridor

Material

Acoustical Tile ☑ Gypsum Board ☐ Plaster ☑

Method of Attachment

Suspended ☑ Metal Channels ☑ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

3. **Light Fixtures**

Typical Room

Recessed ☑ Surface Mounted ☐ Pendant (Suspended) ☐

Typical Corridor

Recessed ☑ Surface Mounted ☐ Pendant (Suspended) ☐

4. **Mechanical Equipment**

Location of Mechanical Equipment Room

Basement ☑ Other Floor ☑ Which Floor 1ST & 2ND

Roof ☐

Is Equipment Anchored to Floor? No ☐ Yes ☑

Location of The Following Units

Liquid Storage Tank

Cooling Tower OUTSIDE OF BLD'G

Air Conditioning Unit 1ST & 2ND FLOOR

1

5. **Roofing**

Description

Flat ☑ Arched ☐ Gabled ☐ If arched or gabled, sketch section.

Pitched ☐ Slope (:12)

Parapet No ☐ Yes ☑ Height (3 ft. 8¼ in.) Thickness (8½ in.)

Material 6" CONC. Special Anchorage or Bracing Yes ☐ No ☑
3½" PRECAST CONC. PANEL

Type

Built-up gravel ☑ Gravel ☐ Asphalt or Wood Shingles ☐

Clay Tile ☐ Other ☐

6. **Windows**

Type

Fixed ☑ Movable ☐

Frame Material:

Aluminum ☐ Steel ☑ Stainless Steel ☐ Wood ☐

Size: Average Size of Casing (6'-9" ft. x ____ ft.) SEE ELEVATIONS

Average Size of Glazing (4 ft. 0 in. x 4 ft. 5 in.)

How Casing is Attached to Structure

Bolted ☑ Screwed ☐ Clipped ☐ Welded ☐ Nailed ☐
3/8"φ BOLTS @ 24" o.c.

Glazing Attachment to Casing

Elastomeric Gasket ☐ Glazing Bead ☑ Aluminum or Steel Retainer ☐

Other ☐

7. Gas Connection

Flexible Connection to Building ☑ Rigid Connection to Building ☐

Automatic Shut-off ☐ None ☐ Unknown ☐

INSPECTED BY [redacted]

DATE [redacted]

FIELD SUPERVISOR [redacted]

4.3 FIELD EVALUATION METHOD

A. Earthquake

The rating forms are completely based on the information in the Data Collection Form. From the elevation of Wall A, it will be noticed that two large concrete wall elements in the first story do not appear in the second story. A second floor plan was not drawn, but a note was placed on the first floor plan that these two piers are not present in the second story. This creates some eccentricity in the upper story vertical resisting system for longitudinal loading which is reflected in the symmetry rating.

The field investigation showed no cracks in the concrete shear walls and no evidence of cracks or looseness of the precast exposed aggregate or granite veneers. The anchorage of these veneer elements, according to the plans and specifications, appeared to be adequate.

The plans show that this building was constructed in the 1960's and the building code of that period would require earthquake resistant design.

FORM FMA-1

FACILITY NO. RC BUILDING EXPECTED SITE MODIFIED MERCALLI INTENSITY 9.5

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

VERTICAL RESISTING ELEMENTS							
Type	General Rating (GR)		Symmetry (S)	Quantity (Q)	Symmetry Quantity Rating (SQR) [1]	Present Condition (PC)	Sub-Rating (SR1) [2]
	E	W					
TRANSVERSE LOADING							
F	1	1	1	3	2	1	1.3
LONGITUDINAL LOADING							
F	1	1	2	3	2.5	1	1.5

FOOTNOTES:

1. Symmetry-Quantity Rating (SQR) = $\frac{S + Q}{2}$.
2. Sub-rating SR-1 = $\frac{SQR + 2PC}{3}$.

	TYPE	GENERAL RATING (GR) Earthquake	GENERAL RATING (GR) Wind
A	Steel Moment Resistant Frames	1	1
B	Steel Frames - Moment Resistance Capability Unknown	2	2
C	Concrete Moment Resistant Frames	1	1
D	Concrete Frames - Moment Resistance Capability Unknown	2	2
E	Masonry Shear Walls - Unreinforced	4	2 or 3
F	Masonry or Concrete Shear Walls - Reinforced	1	1
G	Combination - Unreinforced Shear Walls and Moment Resistant Frames	2	2
H	Combination - Reinforced Shear Walls and Moment Resistant Frames	1	1
J	Braced Frames	1	1
K	Wood Frame Buildings, Walls Sheathed or Plastered	1 or 2	2 or 3
L	Wood Frame Buildings, Walls Without Wood Sheathing or Plaster	4	4

SYMMETRY (of Resisting Elements)

1	Symmetrical
2	Fairly Symmetrical
2 or 3	Symmetry Poor
3 or 4	Very Unsymmetrical

NOTE: Add 1 (not to exceed 4) to each rating if a high degree of vertical non-uniformity in stiffness occurs.

QUANTITY (of Resisting Elements)

1	Many Resisting Elements
2	Medium Amount of Resisting Elements
3	Few Resisting Elements
4	Very Few Resisting Elements

NOTE: If exterior shear walls are at least 75% of building length, this rating will be 1.

PRESENT CONDITION (of Resisting Elements)

1	No Cracks, No Damage
2	Few Minor Cracks
3	Many Minor Cracks or Damage
4	Major Cracks or Damage.

NOTE: If masonry walls, note quality of mortar - good or poor. If lime mortar is poor, use next higher rating.

FACILITY NO. R.C. BUILDING FORM FMA-2

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

HORIZONTAL RESISTING ELEMENTS

Type		Rigidity (R)	Anchorage & Connections (A)	Chords (C)		Sub-Rating (SR2)
				Longitudinal	Transverse	
Roof	A	1.	1	1	1	1
Floors	A	1.	1	1	1	1

Note: Sub-rating SR2 = Largest of R, A or C.

Type	
A	Diaphragm
B	Steel Horizontal Bracing

Rigidity - Ratings	
1.	Rigid
1.5	Semi-rigid
2.0	Semi-flexible
2.5	Flexible

Anchorage and Connections - Ratings

1 Anchorage confirmed - capacity not computed, but probably adequate.
2 Anchorage confirmed - capacity not computed, but probably inadequate.
3 Anchorage unknown.
4 Anchorage absent.

Chords - Ratings

1 Chords confirmed, but capacity not computed.
2 Chords unknown, but probably present.
3 Chords unknown, but probably not present.
4 Chords absent.

FACILITY NO. R.C. BUILDING

FIELD EVALUATION METHOD

EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

TYPE OF WALL	REINFORCEMENT			ANCHORAGE					WALL RATING
	Present	Not Present	Not Known	Mortar Only	Dowels	Screws or Bolts	Other	Not Known	
Brick									
Brick									
Concrete Block									
Concrete Block									
Reinforced Concrete									
Tilt-up or Precast Concrete									
Steel Studs & Plaster						✓			A
Wood Studs & Plaster									
Hollow Tile									
Hollow Tile & Plaster									

NOTE: Wall Rating on Basis of A, B, C, and X.

FACILITY NO. R.C. BULDING

FORM FMB-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	RATING
Partitions Other Than on Corridors or Stair Enclosures	A
Glass Breakage	B
Ceiling	B
Light Fixtures	B
Exterior Appendages and Wall Cladding*	A

Ratings
A = Good
B = Fair
C = Poor
X = Unknown

*A description of some of the ratings for Exterior Appendages and Wall Cladding are:

Description	Rating
Spacing of anchors appears satisfactory	A
Size and embedment of anchors satisfactory	A
Spacing of anchors appears to be too great	B
Size and embedment of anchors appears unsatisfactory	C
Anchorage unknown	X
Anchorage corroded or obviously loose	C
No anchorage	C

EARTHQUAKE GAS CONNECTION		
Present	Not Present	Not Known
✓		

B. Wind

This two-story, reinforced concrete structure is exposed to a basic wind speed of 100 miles per hour with Exposure "C."

The comments in the preamble for earthquake relative to location of shear walls and attachments of precast concrete panel veneer are also applicable to wind evaluation.

The information necessary for evaluation of the structural system is given with the earthquake evaluation on Form FMA-1.

FACILITY NO. R.C. BUILDING

FIELD EVALUATION METHOD

STRUCTURAL SYSTEM - WIND RATING

BUILDING DESIGNATION:										
* Exposure A,B or C	* Basic Wind Speed (V_2)	Building Height	* Effective Velocity Pressure (q_F)	**** Design Unit Pressure q_Fx1.4=P	** Basic Structural Rating	Uplift Anchorage Factors Foundation	Uplift Anchorage Factors Roof	*** Corrected Structural Rating	Effective Unit Velocity Pressure Capacity P_c	Capacity Ratio $\frac{P}{P_c}$
B	100	32'	33	43	1.5	1	1	1.5	40	1.1

* See ANSI A58.1-72. q_F in pound per square foot.

** From Structural Systems - Form FME.

*** Use Maximum Anchorage Factor (Foundation or Roof) or the Basic Structural Rating, whichever is greater.

**** q_F x 1.3 = P for buildings with height to length ratio less than 2.5.

ANCHORAGE FACTORS

BUILDING TYPE	UPLIFT ANCHORAGE TO FOUNDATION	FOUNDATION ANCHORAGE FACTOR[1]	UPLIFT ANCHORAGE OF ROOF	ROOF ANCHORAGE FACTOR[1]
Heavy Buildings	Good	1.0	Good	1.0
Heavy Buildings	Poor	1.5	Poor	4.0
Light Buildings	Good	1.0	Good	1.0
Light Buildings	Poor	4.0	Poor	4.0

CORRECTED STRUCTURAL RATING	P_c
1. -	45
1.1 to 1.5	40
1.6 to 2.0	30
2.1 to 3.0	20
3.1 to 3.5	10
3.6 to 4.0	5

[1] Factors should be increased 0.5 (not to exceed 4.0) if the building is primarily un-enclosed.

FACILITY NO. R.C. BUILDING FORM FMC-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - WIND RATING

TYPE OF RISK	RATING
Glass Breakage	B
Window Frame Anchorage	B
Roof Panel Anchorage	A
Wall Panel Anchorage	A
Anchorage of Exterior Appendages	A

A = Good; B = Fair; C = Poor; X = Unknown.

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE

TYPE	QUANTITY	DISTANCE
LUMBER YARD	LARGE	400'

C. Tornado

The building is assumed to be in a location subject to tornado hazard. The basis used for tornado evaluation is the information obtained in wind evaluation and is shown on Form FMC-1 and FMC-2. Using this information, the tornado ratings are placed on Form FMD. Form FMD only rates buildings capable of sustaining an effective unit velocity pressure of 40 psf or over. The tornado wind pressures, both positive and negative, are much higher than this. However, the relatively short duration of extremely high tornado wind forces is recognized in these ratings on Form FMD.

FACILITY NO. R.C. BUILDING FORM FMD

FIELD EVALUATION METHOD

TORNADO RATING

EFFECTIVE UNIT VELOCITY PRESSURE CAPACITY P_c (From FMC-1)	DOES BUILDING QUALIFY AS A VAULT-TYPE STRUCTURE?		TORNADO RATING BUILDING-AS-A-WHOLE
40	Yes ☐	No ☑	FAIR

BUILDING-AS-A-WHOLE RATINGS

Vault Type Building - Good
P_c = 40 p.s.f. or over - Fair
P_c = 20 to 40 p.s.f. - Poor
P_c = Under 20 p.s.f. - Very Poor

HAZARD FROM WIND-BLOWN DEBRIS				
	LOCATION	TYPE	NOT PRESENT	RATING
Wall Cladding, Appendages, or Glass	VENEER ALL SIDES WINDOWS ALL SIDES	PRECAST CONC. PANELS & GRANITE GLASS & ST'L SASH		GOOD POOR
Other Potential Debris Not Part of The Building			✓	

WIND-BLOWN DEBRIS RATINGS

Not Present - Good
Small Quantity of Potential Hazard - Fair
Large Quantity of Potential Hazard - Poor

BASEMENT STORM SHELTER AVAILABILITY	
Present	Yes ☑ No ☐
Capacity*	633
Suitability**	SATISFACTORY

*Based on 15 sq. ft. per person.

**See Section 3.2E.

D. Resume

Earthquake

The Field Method of Evaluation rates this building "Poor" for its ability to resist an earthquake of Modified Mercalli Scale Intensity of 9.5, which is a very severe earthquake. It would rate "Fair" for an earthquake of Modified Mercalli Scale VIII, and "Good" for an earthquake of Modified Mercalli Scale VII or less.

The steel stud and plaster partitions are rated "A" (Good). Some plaster cracking would be expected in earthquakes of MMI VI or greater. Failure of the structural elements would cause severe damage to the partitions, however.

Some glass breakage and falling of light fixtures could be expected in earthquakes of MMI VIII or greater. Some ceiling panels would probably fall in the higher intensity earthquakes.

Wind

The rating of this example is "Fair" for a Basic Wind Speed of 100 mph Very little damage to "Other Life Hazards" would be expected from winds of a Basic Wind Speed of 100 mph.

Tornado

The rating of this example for tornado is "Fair." It is a rather heavy building and the reinforced concrete roof will probably resist considerable uplift. Most of the exterior glass would be broken. The basement has an effective area to house over 600 people for a short period of time. The concrete joist system of the first floor is considered the equivalent to a solid 6 in slab.

FACILITY NO R.C. BUILDING

FORM FME

FIELD EVALUATION METHOD

CAPACITY RATIOS - EARTHQUAKE AND WIND RATING

	General Rating (GR)	Sub-Rating		Basic Structural Rating*	Capacity Ratio**
		SR1	SR2		
EARTHQUAKE	1	1.5	1	1.5	1.5
WIND	1	1.5	1	1.5	1.1

*Basic Structural Rating = $\frac{\text{GR + 2 (Largest of SR1 or SR2)}}{3}$.

**Capacity Ratio for wind shall be obtained from Form FMC-1. For earthquake, the ratio is obtained from the Basic Structural Rating divided by the Intensity Level Factor at the site as determined from the table below.

Modified Mercalli Scale	Intensity Level Factor
VIII or Greater	1
VII	2
VI	3
V or Less	4

A description of Modified Mercalli Scale is included on table 3.3.

Capacity Ratio Rating	
Capacity Ratio	Rating (In Terms of Risk
Less than 1.0	Good
1 through 1.4	Fair
1.5 through 2.0	Poor
Over 2.0	Very Poor

4.4 APPROXIMATE ANALYTICAL EVALUATION METHOD

A. Earthquake

In this example the critical elements to be analyzed for resisting seismic forces are the wall piers, particularly on the first story and the floor and roof diaphragms. The seismicity of this location is assumed to be a MMI of 9.5. Thus the Z_s factor is 1.25 (from Formula $2 \log 5 Z_s = - 1.973 + .375$ MMI). Computations for this building were available. These were made based on seismic design criteria of 1961 UBC. Since 1973, UBC criteria [2.5] are somewhat different, particularly for shear wall design. New computations were necessary. However, the original calculations were of assistance.

This building has a complete vertical load-carrying frame with K of 1.0. As the building is two-story, the C value is .10. The base shear as determined from the formula $V = ZKCW$ is therefore $V = 1.25 \times .1 \times W$, where W is the total dead load.

The concrete shear walls are assumed to resist 100% of the lateral forces. The concrete joist systems of the second floor and roof act as horizontal diaphragms to distribute lateral forces to these shear walls.

The dead loads of floors, roofs and walls are computed and a loading diagram is made for each level in each direction and the reactions are computed. See Computation Sheets E2 and E10. The centers of mass for the two levels are then computed.

Next the relative stiffnesses of the various shear walls are obtained, see Computation Sheet E5. It is convenient to use Wall Analysis forms for this. Deflections are read from the chart given in figure 3.11. Walls A, B, C, and D as shown on the DC form are listed in the first column. The next column lists the piers in each wall. In this example, Walls B and D are alike in both stories. The terms "h" and "d" refer to the clear height and width of the piers. The term "Δ" is the deflection of a pier under a load of 1,000,000 pounds and is read from the chart. "K" in this case is the stiffness factor which is the recriprocal of the deflection.

Since all the walls have the same concrete strength and only relative stiffnesses are in the analysis, the modulus of elasticity of 3,000,000 psi as used in the chart may be used in the analysis.

The stiffness of each pier in each wall is combined to obtain the total wall stiffness. This simplifies the computation of the center of resistance. These centers are shown on the loading diagram computation sheets (E-2 and E-10 in the manner shown on Sheets E3 and E4).

The total horizontal force is distributed in proportion to the relative stiffness of the walls. Because of this method of proportioning, the center of mass does not coincide with the center of rigidity. This results in eccentricity thereby creating torsion. The code requires an arbitrary or "accidental" torsion considered in the analysis. These torsional increments are computed in tables on Computation Sheet E18. A legend of terms in these tables is given on Sheet E19. Either direct or accidental torsional moments add to the direct loads computed on the basis of relative stiffnesses alone. The "Factored Design Load" uses a 1.4 multiplier applied to the "Design Load." This 1.4 factor is taken from the Tri-Service Manual [3.1] from Section 2609(d) of the 1973 UBC [2.5] rounded off to the nearest tenth. It is this Factored Design Load that is used in analyzing the individual piers by the Strength Method.

In this example all of the wall piers are potential critical elements and require a specific determination of stresses to determine which is the most critical element. Since these wall piers are non load-bearing, the effect of vertical loads are not considered in the analysis for earthquake forces to the wall. The ratios f_e/f_a are then computed. These ratios show the relative compliance or non-compliance and the most critical f_e/f_a ratios are noted on Form AMA-1. A typical wall is also checked for earthquake forces normal to the wall. This is shown on Computation Sheet E20. The diaphragm shears are noted on the loading diagram sheets. The unit shears and chord stress ratios are then computed on Sheets E9 and E16.

In filling out Form AMB-2, some computations would normally be needed. For this example, some of the items are indicated with critical stress ratios of greater than 1. In the case of "Partitions Other than on Corridors" or "Stair Enclosures" the metal stud and plaster walls with 4 ft metal studs at 16in on center are adequate to span the comparatively low story or ceiling heights in this building and no computations were made.

The only "Exterior Appendage" is the narrow concrete canopy. Unless the earthquake had a vertical component in excess of 1g, this would not fail No computations are made to verify this.

The wall caldding is a thin precast concrete slab used as a form or is thin granite or tile veneer anchored by adhesives. The bond is considered to be good. No computations are required for this item in this case.

FACILITY NO. R.C. BUILDING   FORM AMA-1

APPROXIMATE ANALYTICAL METHOD
STRUCTURAL SYSTEMS - EARTHQUAKE RATING

BUILDING DESIGNATION:

Type of Frame	Type of Diaphragm	Modified Mercalli Intensity	Z_s	Z_c	Critical Elements		Critical Stress Ratio (f_e/f_a)
					Type	Location	
D & F	REIN-FORCED CONCRETE	9.5	1.25	1.0	SHEAR WALL	2ND STORY CORNER PIERS (SHT. E9)	1.32
						1ST STORY B, D & A WALLS ALL PIERS (SHT. E-15)	2.96

TYPE

A Steel Moment Resistant Frames
B Steel Frames - Vertical Load Carrying Only
C Concrete Moment Resistant Frames
D Concrete Frames - Vertical Load Carrying Only
E Masonry Shear Walls - Unreinforced
F Masonry or Concrete Shear Walls - Reinforced
G Combination - Unreinforced Shear Walls and Moments Resistant Frames
H Combination - Reinforced Shear Walls and Moment Resistant Frames
J Braced Frames
K Wood Frame Buildings, Walls Sheathed or Plastered
L Wood Frame Buildings, Walls Without Wood Sheathing or Plaster
M Other

Z_s = Zone factor determined for site from Modified Mercalli Intensity.

Z_c = Zone factor from Code.

NOTE: For rating of Structural Systems, use Form AME.

FACILITY NO. R.C. BUILDING

APPROXIMATE ANALYTICAL METHOD
EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

Type of Wall	Reinforcement		Anchorage				Critical Stress Rating f_e/f_s	Rating*
	Present	Not Present	Mortar Only	Dowels	Screws or Bolts	Other		
Brick		✓						
Brick		✓						
Concrete Block		✓						
Concrete Block		✓						
Reinforced Concrete	✓						1.02 (PAGE 3 SHT. E17)	FAIR
Tilt-up or Precast Concrete		✓						
Steel Studs & Plaster	✓				✓		> 1.0	GOOD
Wood Studs & Plaster		✓						
Hollow Tile		✓						
Hollow Tile & Plaster		✓						

*Obtained from Form AME

FACILITY NO. R.C. BUILDING FORM AMB-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING*
Partitions Other Than on Corridors or Stair Enclosures	< 1.0	GOOD
Exterior Appendages and Wall Cladding	< 1.0	GOOD
Ceiling	NOT LATERALLY BRACED	POOR
Light Fixtures	RECESSED INTO UNBRACED CEIL'G	POOR

*See Form AME - Rating of Critical Stress Ratios.

DESIGN CRITERIA

LOAD CRITERIA

ROOF		2ND FLOOR	
5 PLY ROOFING + GRAVEL	= 7.0 p.s.f.	2½" LIGHT WEIGHT FILL	= 23.0 p.s.f.
JOIST	= 72.0	JOIST	= 72.0
BEAMS	= 9.0	BEAMS	= 10.0
CEILING	= 10.0	CEILING	= 10.0
PARTITION	= 10.0	PARTITION	= 20.0
	108.0 p.s.f.		135.0 p.s.f.

CONCRETE WALLS = 150 p.c.f.

2½" PRECAST CONCRETE VENEER = 31.25 p.s.f.

ROOF LIVE LOAD = 20.0 p.s.f.

FLOOR LIVE LOAD = 100.0 p.s.f.

CHECK LATERAL LOADS FOR 1973 UNIFORM BUILDING CODE

$V = ZKCW = 1.25 \times 1.0 \times 0.1\,W = 0.125\,W$

$Z = Z_3 = 1.25$

$K = 1.0$

$C = 0.1$

(SEISMIC FORCE ON ROOF) $F_R = .125\,W_R$

(SEISMIC FORCE ON 2ND FLOOR) $F_2 = .125\,W_2$

W_R = 100 % WEIGHT OF ROOF

W_2 = 100 % WEIGHT OF 2ND FLOOR

$V_2 = .125\,(W_R + W_2)$

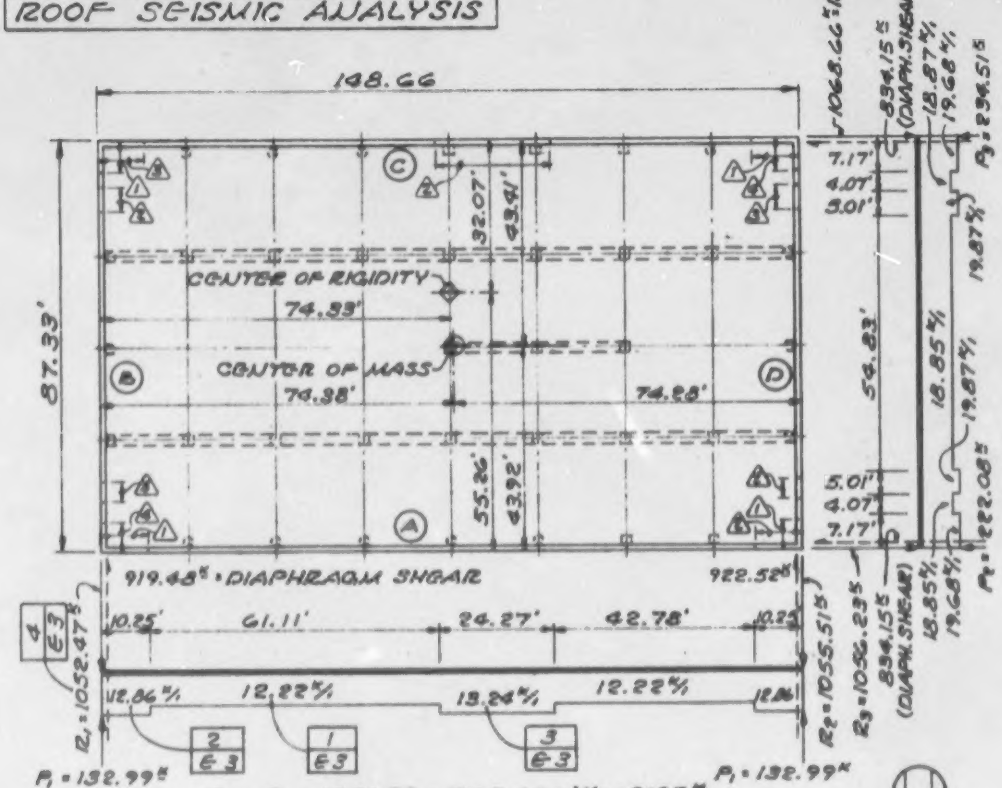
DESIGN STRESS CRITERIA (FROM THE PLANS & SPECIFICATIONS)

CONCRETE $f'_c = 2500$ p.s.i.

REINFORCING STEEL $f_y = 40{,}000$ p.s.i.

ALLOWABLE SOIL PRESSURE = 1800 p.s.f. (DEAD + LIVE)

ROOF SEISMIC ANALYSIS


148.66
87.33'
Ⓒ
Ⓐ
Ⓑ
Ⓓ
32.07'
43.41'
CENTER OF RIGIDITY
74.33'
CENTER OF MASS
74.38'
74.28'
55.26'
43.92'
1068.66k = R4
834.15k (DIAPH. SHEAR)
18.87k/'
19.68k/'
P3 = 234.51k
7.17'
4.07'
3.01'
19.87k/'
54.83'
18.85k/'
19.87k/'
5.01'
4.07'
7.17'
P4 = 222.08k
R3 = 1056.23k
834.15k (DIAPH. SHEAR)
18.85k/'
19.68k/'
919.48k = DIAPHRAGM SHEAR
922.52k
4 E3
R1 = 1052.47k
10.25'
61.11'
24.27'
42.78'
10.25'
12.86k/'
12.22k/'
13.24k/'
12.22k/'
12.86
2 E3
1 E3
3 E3
R2 = 1055.51k
P1 = 132.99k
P1 = 132.99k
II

$R_3 + R_4 = 1056.23 + 1068.66 = \underline{W_R = 2125^k}$

LOADS FOR ROOF DIAPHRAGM
PIERS NUMBERED △ ARE IN WALL BELOW

SPANDREL + 2½" PRECAST CONCRETE VENEER

$3.75 \times 1.65 \times 150$ p.c.f. = 928 p.l.f.

CONCRETE CANOPY

$1.69 \times 0.375 \times 150$ p.c.f. = 95 p.l.f.

10" WALL + 2½" PRECAST VENEER

$1.05 \times 3.25 \times 150 = 512$ p.l.f.

PARAPET

$3.5 \times 0.71 \times 150 = 37.3$ p.l.f.

WALL "B" OR "D"

$P_1 = (.373 + .928)\,87.33 + (.095 \times 72.79)$
$+ (.512 \times 24.35) = 132.99^k$

ROOF SEISMIC ANALYSIS

LOADS FOR ROOF DIAPHRAGM (CONT.)

WALL "A"

$P_2 = (.373 + .928)\,148.66 + (.095 \times 128.17) + (.512 \times 20.5) = 222.08^{K}$

WALL "C"

$P_3 = (.373 + .928)\,148.66 + (.095 \times 128.17) + (.512 \times 44.71) = 234.51^{K}$

CONCRETE COLUMNS + BRIDGING = 670.0 p.l.f.
ROOF LOAD = 108 × 87.33 = 9431.6 p.l.f.
SPANDREL 2 × 928 = 1856.0
CANOPY 2 × 95 = 190.0
PAPAPET 2 × 37.3 = 74.6
12222.2 p.l.f. $\boxed{\frac{1}{E3}}$

EXTERIOR ½ BAYS COLS. + BRIDGING = 480 p.l.f.
ROOF = 9431.6
SPANDREL = 1856.0
PARAPET = 74.6
WALL = 2 × 512 = 1024.0
12866.2 p.l.f. $\boxed{\frac{2}{E3}}$

CENTER PORTION = 12222
WALL = 2 × 512 = 1024
13246 p.l.f. $\boxed{\frac{3}{E3}}$

DIAPHRAGM SHEAR = REACTION OF LOAD TO DIAPH. = 919.48
WEIGHT OF WALL B TRIBUTARY TO ROOF = P_1 = 132.99
REACTION OF WEIGHT AT WALL B = R_1 = 1052.47
$\boxed{\frac{4}{E3}}$

DETERMINE CENTER OF RIGIDITY (C.R.) AND CENTER OF MASS (C.M.) FOR NORTH-SOUTH SEISMIC

WALLS "B" AND "D" ARE SIMILAR ∴ (C.R.) IS IN CENTER
148.66 ÷ 2 = 74.33 ft. FROM EXTERIOR OF WALL "B" OR "D"

$$\begin{array}{llll} \text{(C.M.)} = & 1052.47 & \times\ .625 & 657.79 \\ & \underline{1055.51} & \times\ 147.92 = & \underline{156133.76} \\ & 2107.98 & & 156791.55 \end{array}$$

$$\text{(C.M.)} = \frac{156791.55}{2107.98} = 74.38' \text{ FROM EXTERIOR OF WALL "B"}$$

ROOF SEISMIC ANALYSIS

DETERMINE CENTER OF RIGIDITY (C.R.) AND CENTER OF MASS (C.M.) FOR EAST - WEST SEISMIC

WALL "A" RIGIDITY K = 34.25 SHT. E5
WALL "C" RIGIDITY K = 59.52 SHT. E5

$$
\begin{array}{llll}
(C.R.) = & 34.25 & \times .625 = & 21.42 \\
 & \underline{59.52} & \times 86.71 = & \underline{5160.98} \\
 & 93.77 & & 5182.40
\end{array}
$$

$$(C.R.) = \frac{5182.40}{93.77} = 55.26' \text{ FROM EXTERIOR OF WALL "A"}$$

$$
\begin{array}{llll}
(C.M.) = & 1056.23 & \times .625 = & 660.14 \\
 & \underline{1068.66} & \times 86.71 = & \underline{92663.51} \\
 & 2124.89 & & 93323.65
\end{array}
$$

$$(C.M.) = \frac{93323.65}{2124.89} = 43.92' \text{ FROM EXTERIOR OF WALL "A"}$$

SEISMIC FORCE ON ROOF

$F_R = .125\ W_R$
$= .125 \times 2125 = 265.63$ KIPS

WALL ANALYSIS - SEISMIC

WALL	PIER	h*	d	h/d	Δ	K	WALL K	H TO WALL	H TO PIER	M	A_s	V_u	REMARKS
2ND STORY WALLS								***					
B & D (EAST & WEST)	1CF**	7.0	7.0	1.0	.0875	11.42		192.7	67.7	237	1.28	237	ALL PIERS HAVE 2-#7 JAMB BARS =1.20□"
	2RF	7.0	5.0	1.40	.190	5.26			31.2	109	0.865	153	
	3RF	7.0	5.0	1.40	.190	5.26			31.2	109	0.865	153	
	4CF	7.0	7.0	1.0	.0875	11.42			67.7	237	1.28	237	
						33.36							
	(FOR PIER LOCATION SEE PLAN SHEET E2)												WALLS HAVE #4@20" o.c. B.W. B.F. ∴ ALLOWABLE SHEAR V_u =180 p.s.i.
	WALL	14	86.6	0.16	.014	(Δ SOLID WALL)							
	BAND @ WINDOW	7.0	86.6	0.08	.007	(Δ BAND WINDOW HEIGHT)							
	Δ 1,2,3,4 = $\frac{1}{33.36}$ = .03 (Δ PIERS 1,2,3,4)												
Δ	WALL = .014 - .007 + .03 = .037 (Δ WALL WITH WINDOWS OUT)												
						K WALL = $\frac{1}{.037}$ =	27.03						
A (NORTH)	1CF	7.0	10.25	0.68	.053	18.87		152.7	76.4	267.4	0.99	182.7	BOTH PIERS HAVE 2 #7 JAMB BARS =1.20 SQ. IN.
	2CF	7.0	10.25	0.68	.053	18.87			76.4	267.4	0.99	182.7	
						37.74							
	WALL	14.0	148.25	.094	.0065	(Δ SOLID WALL)							FOR M, A_s AND V_u SEE SHEETS E-6 AND E 7
	BAND @ WINDOW	7.0	148.25	.047	.0033	(Δ BAND WINDOW HEIGHT)							
	Δ 1,2 = $\frac{1}{37.74}$ = .026 (Δ PIERS 1, 2)												
Δ	WALL = .0065 - .0033 + 026 = .0292												
						K WALL = $\frac{1}{.0292}$ =	34.25						
C	1CF	7.0	10.25	0.68	.053	18.87		248.2	63.8	223	.829	152.6	ALL PIERS HAVE 2-#6 =.885 SQ. IN.
	2RC	7.0	23.8	0.29	.028	35.71			120.7	844.9	1.0	124.6	
	3CF	7.0	10.25	0.68	.053	18.87			63.8	223	.829	152.6	
						73.45							
	Δ 1,2,3 = $\frac{1}{73.45}$ = .0136												
Δ	WALL = .0065 - .0033 + .0136 = .0168												
						K WALL = $\frac{1}{.0168}$ =	59.52						

* h = HEIGHT IN FEET
d = DEPTH IN FEET (LENGTH)
Δ = RELATIVE DEFLECTION FROM CHART 6-3-1 TRI SERVICE MANUAL
K = STIFFNESS FACTOR
H = HORIZONTAL FORCE IN KIPS
M = MOMENT IN FOOT KIPS
A_s = AREA OF STEEL IN SQ. INCHES
V = UNIT SHEAR IN LBS. PER SQ. INCH

** CF = CORNER PIER FIXED
RF = RECTANGULAR PIER FIXED
RC = RECTANGULAR PIER CANTILEVER INDICATING THE CURVE USED ON PLATE 6-3-1 OF TRI SERVICE MANUAL

*** H TO WALL IS FACTORED DESIGN LOAD FROM SHEET AM-E 18

AM-E6

ROOF SEISMIC ANALYSIS

CHECK WALL PIERS 2ND STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

WALL "B" & "D"

PIER 1 & 4

2 #7 EXISTING REINFORCEMENT AT JAMBS = 1.20 SQ. IN
(FROM PLAN)

$$q = \frac{A_s f_y}{b d f'_c} = \frac{1.2 \times 40000}{10 \times 81 \times 2500} = .0237$$

$$a_u = \frac{\phi f_y (1 - .59q)}{12{,}000} = \frac{.9 \times 40000 (1 - .59 \times .0237}{12000} = 2.96 \quad \left(\begin{matrix}\text{ACI} \\ \text{SP No. 17}\end{matrix}\right)$$

$$M = \frac{67.7 \times 7}{2} = 237^{\text{'K}}$$

$$A_s = \frac{237}{2.96 \times 81} = 0.99^{\square''} \times 1.33 (\text{ACI } 10.5.1) = 1.28^{\square''}$$

STRESS RATIO $\frac{f_e}{f_a} = \frac{1.28}{1.20} = 1.067$ (FLEXURAL TENSION)

SHEAR

$v_u = \frac{V_u}{\phi h d} = \frac{2 \times 67700}{.85 \times 10 (84 \times .8} = 237$ p.s.i. (FOR V_u USE 2.8E UBC 2627(a))

$v_c = 2\sqrt{f'_c}$ (11.4.1 ACI 318-71)

$v_c = 2\sqrt{2500} = 100$ p.s.i.

WALLS REINFORCED WITH #4 @ 20" o.c. BOTH WAYS BOTH FACES

$A_v = \frac{(v_u - v_c) b_w S}{f_y}$ (11.6.1 ACI 318-71)

$$v_u = \frac{A_v f_y}{b_w S} + v_c$$

$$v_u = \frac{.40 \times 40000}{10 \times 20} + 100$$

$v_u = 180$ p.s.i. ALLOWABLE WITH EXISTING REINFORCING

STRESS RATIO $\frac{f_e}{f_a} = \frac{237}{180} = 1.32$ (SHEAR)

CHECK COMPRESSIVE STRESS IN THE CONCRETE

$f_c = .85 f'_c = .85 \times 2300 = 2125$ p.s.i.

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{1.2 \times 40{,}000}{2125 \times 10} = 2.259$ IN.

$$j_u d = \left(81 - \frac{2.259}{2}\right) = 79.87''$$

ROOF SEISMIC ANALYSIS

CHECK WALL PIERS 2ND STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR (CONT.)

WALL "B" & "D" (CONT.)

CHECK COMPRESSIVE STRESS IN THE CONCRETE (CONT.)

$C = 2.259 \times 2125 \times 10 = 48000$ LB.

$M_u = \frac{.9 \times 79.87 \times 48}{12} = 287.55$ FT. KIPS

STRESS RATIO $= \frac{237}{287.53} = 0.82$ NOT CRITICAL

FOR THE COMPRESSION STRESS RATIO THE EFFECT OF COMPRESSIVE STEEL WAS NOT CONSIDERED. IN MOST CASES THE COMPRESSIVE STRESSES IN PIERS ARE NOT CRITICAL AND IT IS NOT CHECKED IN THE REST OF THIS EXAMPLE.

THE OVERALL BUILDING PROPERTIES ARE NEGLECTED FOR DETERMINING REINFORCEMENT REQUIREMENTS OF INDIVIDUAL PIERS BECAUSE FOR LOW BUILDINGS OF THIS TYPE IT DOES NOT CHANGE THE REINFORCEMENT REQUIREMENTS.

PIER 2 & 3

$M = \frac{31.2 \times 7}{2} = 109^{'k}$ $\quad a_u = 2.94$ $\quad$ 2-#7 JAMB BARS = 1.20

$A_s = \frac{109}{2.94 \times 57} = 0.65$ SQ. IN. $\times 1.33 = 0.87$ SQ. IN

STRESS RATIO $= \frac{0.87}{1.20} = 0.73$ (FLEXURAL TENSION)

$v_u = \frac{2 \times 31200}{.85 \times 10 (60 \times .8)} = 152.9$ p.s.i.

STRESS RATIO $= \frac{0.87}{1.20} = 0.85$ (SHEAR)

WALL "A"

PIER 1 & 2 (FOR LOCATION SEE PLAN SHEET AM-G2)

2-#7 JAMB BARS EXISTING = 1.20 SQ. IN. $a_u = 2.97$

$M = \frac{76.4 \times 7}{2} = 267.4^{'k}$

$A_s = \frac{267.4}{2.97 \times 120} = 0.75 \times 1.33 = 0.99$ SQ. IN.

STRESS RATIO $= \frac{0.99}{1.20} = 0.83$ (FLEXURAL TENSION)

ROOF SEISMIC ANALYSIS

CHECK WALL PIERS 2ND STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR (CONT.)

WALL "A" (CONT.)

$$v_u = \frac{2 \times 76400}{.85 \times 10(123 \times .8} = 182.7 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{182.7}{180.0} = 1.02 \text{ (SHEAR)}$$

WALL "C"

PIER 1 & 3

2-#6 JAMB BARS EXISTING = 0.88 SQ. IN. $a_u = 2.98$

$M = 223^{'K}$

$$A_s = \frac{223}{2.98 \times 120} = .624 \times 1.33 = 0.83 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{0.83}{0.88} = 0.94 \text{ (FLEXURAL TENSION)}$$

$$v_u = \frac{2 \times 63800}{.85 \times 10\,(123 \times .8)} = 152.6 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{152.6}{180} = 0.85 \text{ (SHEAR)}$$

PIER 2

2-#6 JAMB BARS EXISTING = 0.88 SQ. IN. $a_u = 2.99$

$$M = 120.7 \times \frac{7}{1.6} = 528^{'K} \text{(CONSIDER PIER PARTIALLY FIXED)}$$

$$A_s = \frac{528}{2.99 \times 282} = 0.626 \times 1.33 = 0.83 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{0.83}{0.88} = 0.94 \text{(FLEXURAL TENSION)}$$

$$v_u = \frac{2 \times 120{,}700}{.85 \times 10(285 \times .8)} = 124.6 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{124.6}{180} = 0.69 \text{ (SHEAR)}$$

AM-E9

ROOF SEISMIC ANALYSIS

CHECK ROOF DIAPHRAGM SHEAR

(7½" × 16" JOIST + 2½" SLAB)

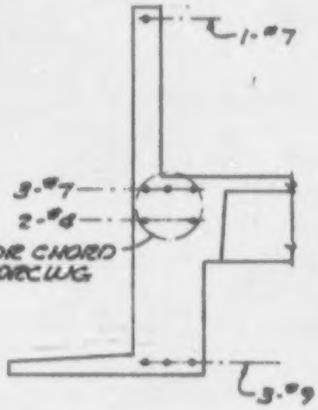
$$922.5^{k}\ (100\%\ G) \times \frac{265.63}{2125} = 115.3^{k}\ (\text{SEISMIC})$$

$$V_u = \frac{1.4 \times 115\,300}{.85 \times 2.5\,(1049 \times .8} = 90.5\ \text{p.s.i.}$$

$$\text{STRESS RATIO} = \frac{90.5}{100} = 0.91$$

CHORD STRESS

$$M = 922.52 \times 73.27 = \begin{array}{r} 67593 \\ \underline{-35565} \\ 32028 \end{array} \times \frac{265.63}{2125} = 4003^{\prime k}$$



$$\begin{array}{lr} -(12.86 \times 10.25) \times 68.5 & = 8983.5 \\ -(12.22 \times 42.78) \times 45.66 & = 23869.7 \\ -13.24 \times \dfrac{(20.24)^2}{2} & = \underline{2711.9} \\ & 35565.1 \end{array}$$

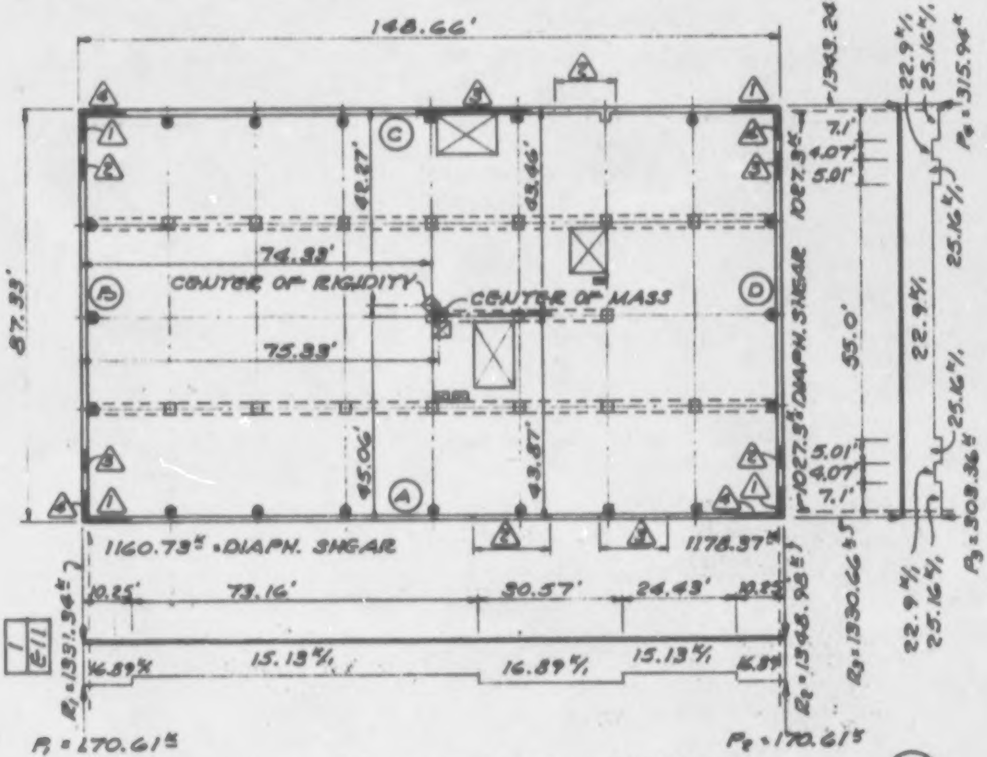
$$T = \frac{4004 \times 1.4}{86.5} = 64.79^{k}$$

$$A_s = \frac{64.79}{.9 \times 40} = 1.79\ \text{SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{1.79}{2.20} = 0.81$$

$$\begin{array}{l} 3\text{-}\#7 = 1.80 \\ 2\text{-}\#4 = \underline{0.40} \\ \qquad\quad 2.20\ \square'' \end{array}$$

SECOND FLOOR SEISMIC ANALYSIS


148.66'
87.33'
C
B
D
A
1
2
3
4
42.27'
43.46'
45.06'
43.87'
74.33'
75.33'
CENTER OF RIGIDITY
CENTER OF MASS
1349.24^k = R4
1027.5^k
DIAPH. SHEAR
1027.5^k DIAPH. SHEAR
55.0'
7.1'
4.07'
5.01'
22.9^k/'
25.16^k/'
P4 = 315.94^k
P3 = 303.36^k
R3 = 1330.66^k
1160.73^k = DIAPH. SHEAR
1178.37^k
10.25'
73.16'
30.57'
24.43'
16.89^k/'
15.13^k/'
R1 = 1331.34^k
R2 = 1348.98^k
1/E11
P1 = 170.61^k
P2 = 170.61^k

$R_1 + R_2 = 1331.34 + 1348.98 = \underline{W_2 = 2680^k}$

LOADS FOR 2ND FLOOR DIAPHRAGM

PIERS NUMBERED △ ARE IN WALL BELOW

SPANDREL + 2½" PRECAST VENEER

3.75 × 1.65 × 150 = 928 p.l.f.

CONCRETE CANOPY

(1) 1.69 × .375 × 150 = 95 p.l.f.
(2) 9 × 0.45 × 150 = 610 p.l.f.

$\therefore \text{AVG} = \frac{95 + 60}{2} = 353$ p.l.f.

7' WINDOW + 3' WALL (8½")

(7 × 10) + (3 × .71 × 150 = 390 p.l.f.

10" WALL + 2½" PRECAST VENEER

1.05 × 10.25 × 150 = 1615 p.l.f.

SECOND FLOOR SEISMIC ANALYSIS

LOADS FOR 2^ND^ FLOOR DIAPHRAGM (CONT.)

WALLS B & D

$P_1 = P_2 = (.928 \times 87.33) + (1.615 \times 24.22) + (.39 \times 63.11) + (.353 \times 73.2)$
$= 170.61$ KIPS

WALL A

$P_3 = (.928 \times 148.66) + (1.615 \times 50.76) + (.39 \times 97.91) + (.353 \times 128.16)$
$= 303.36$ KIPS

WALL C

$P_4 = (.928 \times 148.66) + (1.615 \times 56.8) + (.39 \times 105.16) + (.353 \times 128.16)$
$= 315.94$ KIPS

ROOF LOAD	= 135 × 87.33	= 11789.6
SPANDREL	= 2 × 928	= 1856.0
CANOPY	= 2 × 353	= 706.0
WINDOW + 3' WALL	2 × 390	= 780.0
		151 31.6 p.l.f.

DIAPHRAGM SHEAR = REACTION OF LOADS TO DIAPHRAGM	= 1160.73
WEIGHT OF WALL B TRIBUTARY TO 2^ND^ FLOOR P_1	= 170.61
REACTION OF WEIGHT IN KIPS AT WALL B = R_1	= 1331.34

$\boxed{\frac{1}{E11}}$

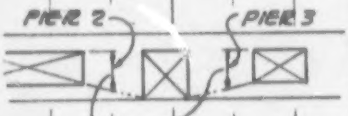
SEISMIC FORCE ON 2^ND^ FLOOR

$F_2 = .125\ W_2$
$= .125 \times 2680 = 335$ KIPS

$V_2 = .125\ (W_R + W_2)$
$= .125\ (2125 + 2680) = 600.6$ KIPS

WALL ANALYSIS - SEISMIC

WALL	PIER	h	d	h/d	Δ	K	WALL K	H TO WALL	H TO PIER	M	A_s	V_u	REMARKS
1ST STORY WALLS													
B	1^{CP}	7.0	7.0	1.0	.0875	11.42		443.8	151.9	531.7	3.0	531.9	ALL PIERS
&	2^{RF}	7.0	5.0	1.40	.190	5.26			70.0	245.0	1.99	343.1	HAVE 2-#7
D	3^{RF}	7.0	5.0	1.40	.190	5.26			70.0	245.0	1.99	343.1	JAMB BARS
(EAST	4^{CP}	7.0	7.0	1.0	.0875	11.42			151.9	531.7	3.0	531.9	= 1.20 □"
& WEST)						33.36							WALLS HAVE #4@20"o.c.B.W.B.F. ∴ ALLOWABLE
							27.03						SHEAR V_u = 180 p.s.i.
A	1^{CP}	7.0	10.0	0.70	.054	18.52		439.4	106.7	373.5	1.43	261.5	ALL PIERS
(NORTH)	2^{RF}	8.5	15.33	.55	.050	20.00			115.2	489.6	1.21	185	HAVE 2-#7
	3^{RF}	8.5	14.83	.57	.052	19.23			110.8	470.9	1.21	184	JAMB BARS
	4^{CP}	7.0	10.0	0.70	.054	18.52			106.7	373.5	1.43	261.5	= 1.20 □"
						76.27							
	WALL	14	148.66	.094	.008								
	BAND @ WINDOW	8.5	148.66	.057	.005								



USE AVE. PIER HEIGHT 8.5'. TO SIMPLIFY FOR APPROX. K

$\Delta\,(1\text{ TO }4) = \dfrac{1}{76.27} = .013$

Δ WALL $.008 - .005 + .013 = .016$

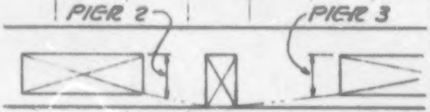
$K\text{ WALL} = \dfrac{1}{.016} = \underline{62.50}$

NOTE: FOR SYMBOLS SEE AM-E5

WALL ANALYSIS - SEISMIC

WALL	PIER	h	d	h/d	Δ	K	WALL K	H TO WALL	H TO PIER	M	As	Vu	REMARKS
1ST STORY WALLS													
C (SOUTH)	1	7.0	10.0	0.70	.054	18.52		466.6	101.7	356.0	1.36	249.3	2-#7 = 1.20
	2	8.5	13.25	0.64	.060	16.67			91.6	389.3	1.10	169.4	2-#7
	3	8.5	22.92	0.37	.032	[illegible]			171.6	729.3	1.19	183.5	2-#9 = 2.0
	4	7.0	10.0	0.70	.054	18.52			101.7	356.0	1.36	249.3	2-#7 = 1.20
						84.96							MAX. Vu = 180 p.s.i.
	WALL	14	148.66	.094	.008								
	BAND @ WINDOW	8.5	148.66	.057	.005								

$\Delta(1 \text{ TO } 4) = \frac{1}{84.96} = .012$



USE AVE. PIER HEIGH 8.5 TO SIMPLIFY FOR APPROX. K

Δ WALL $.008 + .005 + .012 = .015$

K WALL $= \frac{1}{.015} =$ 66.67

NOTE: FOR SYMBOLS SEE AM-E5

AM-E14

SECOND FLOOR SEISMIC ANALYSIS

CHECK WALL PIERS 1^{ST} STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

FOR TYPICAL WALL REINFORCEMENT #4@20" o.c. B.W. B.F.
ALLOWABLE v_u = 180 P.S.I. (SHEET AM-E6)

WALL "B"

PIER 1 & 4

2-#10 JAMB BARS EXISTING = 2.54 SQ. IN. $a_u = 2.91$

$$M = \frac{151.9 \times 7}{2} = 531.7^{1K}$$

$$A_s = \frac{531.7}{2.91 \times 81} = 2.26 \times 1.33 = 3.0 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{f_e}{f_a} = \frac{3.0}{2.54} = 1.18 \text{ (FLEXURAL TENSION)}$$

$$v_u = \frac{2 \times 151\,900}{.85 \times 10 \times (84 \times .8)} = 531.9 \text{ (FOR } V_u \text{ USE 2.8E UBC 2627(a))}$$

$$\text{STRESS RATIO} = \frac{531.9}{180} = 2.96 \text{ (SHEAR)}$$

PIER 2 & 3

2-#10 JAMB BARS EXISTING = 2.54 SQ. IN. $a_u = 2.87$

$$M = \frac{70 \times 7}{2} = 245^{1K}$$

$$A_s = \frac{245}{2.87 \times 57} = 1.50 \times 1.33 = 1.99 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{1.99}{2.54} = 0.78 \text{ (FLEXURAL TENSION)}$$

$$v_u = \frac{2 \times 70000}{.85 \times 10 \times (60 \times .8)} = 343.1 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{343.1}{180} = 1.91 \text{ (SHEAR)}$$

WALL "A" (PIER 1 & 4)

2-#7 JAMB BARS EXISTING = 1.20 SQ. IN. $a_u = 2.97$

$$M = \frac{106.7 \times 7}{2} = 373.5$$

$$A_s = \frac{373.5}{2.97 \times 117} = 1.07 \times 1.33 = 1.43 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{1.43}{1.20} = 1.19 \text{ (FLEXURAL TENSION)}$$

SECOND FLOOR SEISMIC ANALYSIS

CHECK WALL PIERS 1ST STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR (CONT.)

WALL "A" (CONT.)

$v_u = \frac{2 \times 106\,700}{.85 \times 10\,(120 \times .8)} = 261.5$ p.s.i.

STRESS RATIO $= \frac{261.5}{180} = 1.45$ (SHEAR)

PIER 2

2-#7 JAMB BARS EXISTING = 1.20 SQ. IN. $a_u = 2.98$

$M = \frac{115.2 \times 8.5}{2} = 489.6^{\underline{\prime k}}$

$A_s = \frac{489.6}{2.98 \times 180} = 0.91 \times 1.33 = 1.21$ SQ. IN.

STRESS RATIO $= \frac{1.21}{1.20} = 1.00$ (FLEXURAL TENSION)

$v_u = \frac{2 \times 115\,200}{.85 \times 10 \times (183 \times .8)} = 185$ p.s.i.

STRESS RATIO $= \frac{185}{180} = 1.23$ (SHEAR)

PIER 3

$M = \frac{110.8 \times 8.5}{2} = 470.9^{\underline{\prime k}}$

$A_s = \frac{470.9}{2.98 \times 174} = 0.91$ SQ. IN. $\times 1.33 = 1.21$ SQ. IN.

STRESS RATIO $= \frac{1.21}{1.20} = 1.00$

$v_u = \frac{2 \times 110800}{.85 \times 10 \times (177 \times .8)} = 184$ p.s.i.

STRESS RATIO $= \frac{184}{180} = 1.02$

WALL "C"

PIER 1 & 4

2-#7 JAMB BARS EXISTING = 1.20 SQ. IN. $a_u = 2.97$

$M = \frac{101.7 \times 7}{2} = 356.0^{\underline{\prime k}}$

$A_s = \frac{356}{2.97 \times 117} = 1.02 \times 1.33 = 1.36$ SQ. IN.

STRESS RATIO $= \frac{1.36}{1.20} = 1.13$ (FLEXURAL TENSION)

SECOND FLOOR SEISMIC ANALYSIS

CHECK WALL PIERS 1ST STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR (CONT.)

WALL "C" (CONT.)

$$v_u = \frac{2 \times 101700}{.85 \times 10 \times (120 \times .8)} = 249.3 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{249.3}{180} = 1.40 \text{ (SHEAR)}$$

PIER 2

2-#7 JAMB BARS = 1.20 SQ. IN.

$$M = \frac{91.6 \times 8.5}{2} = 389.3$$

$$A_s = \frac{389.3}{2.98 \times 156} = 0.84 \times 1.33 = 1.1 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{1.1}{1.2} = 0.92$$

$$v_u = \frac{2 \times 91600}{.85 \times 10 \times (159 \times .8)} = 169.4 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{169.4}{180} = 0.94$$

PIER 3

2-#9 JAMB BARS EXISTING = 2.0 SQ. IN. $a_u = 2.98$

$$M = \frac{171.6 \times 8.5}{2} = 729.3^{\text{'K}}$$

$$A_s = \frac{729.3}{2.98 \times 272} = 0.90 \times 1.33 = 1.19 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{1.19}{2.0} = 0.60$$

$$v_u = \frac{2 \times 171600}{.85 \times 10 \times (275 \times .8)} = 183.5 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{f_v}{f_a} = \frac{183.5}{180} = 1.02$$

CHECK 2ND FLOOR DIAPHRAGM SHEAR

F_2 = 335 KIPS (SHEET AM-E11)

DIAPHRAGM SHEAR (SHEET AM-E10) $= 1178.37 \times \frac{335}{2680} = 147.3$ KIPS

ROOF DIAPHRAGM SHEAR = 90.5 p.s.i. (SHEET AM-E9)

$$v_u = \frac{147.3}{115.3} \times 90.5 = 115.6 \text{ p.s.i.}$$

2½" SLAB REINFORCED WITH 4"×4"/#10×#10 E.W.M.

No. 10 = 0.135 IN. DIAMETER = 0.0021 SQ. IN. AREA

AM-E17

SECOND FLOOR SEISMIC ANALYSIS

CHECK 2ND FLOOR DIAPHRAGM SHEAR (CONT.)

$$v_u = \frac{f_y A_v}{b_w S} + v_c = \frac{64000 \times .0021}{2.5 \times 4} + 100 = 113 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{115.5}{113} = 1.02$$

CHORD STRESS

$$M = 1160.73 \times 75.52 = 87658.3$$

$$-15.13 \times \frac{(65.77)^2}{2} = 32723.9 \qquad \frac{-44910.7}{42747.6}$$

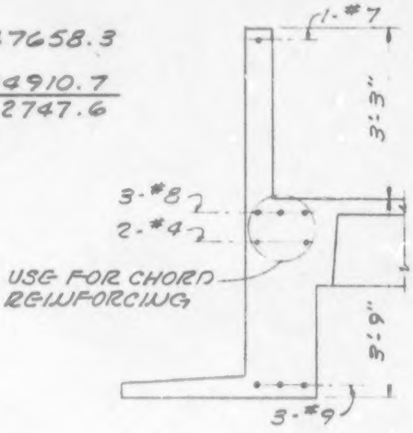
$$-173.12 \times 70.395 = \frac{12186.8}{44910.7}$$

$$\frac{335}{2680} \times 42747.6 = 5343.5^{\underline{1K}}$$

$$T = \frac{5343.5 \times 1.4}{86.5} = 86.5 \text{ KIPS}$$

$$A_s = \frac{86.5}{.9 \times 40} = 2.40 \text{ SQ. IN.}$$

$$\text{STRESS RATIO} = \frac{2.40}{2.77} = 0.87$$



CALCULATE K LOADS TO WALLS

2ND STORY

K FROM SHEET AM-E5

F_R FROM SHEET AM-E4 = 265.6 KIPS

K WALL B = 27.03 $\quad$ K LOAD = $\frac{265.6}{54.06} \times 27.03 = 132.8$ KIPS

D = $\frac{27.03}{54.06}$ $\quad$ = 132.8

K WALL A = 34.25 $\quad$ K LOAD = $\frac{265.6}{93.77} \times 34.25 = 97.0$

C = $\frac{59.52}{93.77}$ $\quad$ " $\times 59.52 = 168.6$

1ST STORY

K FROM SHEET AM-E12 & AM-E13

V_2 FROM SHEET AM-E11 = 600.6 KIPS

K WALL B = 27.03 $\quad$ K LOAD = $\frac{600.6}{54.06} \times 27.03 = 300.3$ KIPS

D = $\frac{27.03}{54.06}$ $\quad$ " $\quad$ = 300.3

K WALL A = 62.50 $\quad$ K LOAD = $\frac{600.6}{129.17} \times 62.5 = 290.6$

C = $\frac{66.67}{129.17}$ $\quad$ " $\times 66.67 = 310.0$

SEISMIC ANALYSIS

DETERMINATION OF DESIGN LOADS TO WALLS

(SEE AM-E19 FOR SYMBOLS AND DEFINITION OF TERMS)

2^{ND} STORY (ROOF DIAPHRAGM)

WALL	K	d^2	Kd^2	$\frac{M_T}{\Sigma Kd^2} \times 10^3$	÷ d	S_{N-S}	S_{E-W}	$S_{ACCID.}$	K LOAD	DESIGN LOAD	FACTORED DESIGN LOAD *
B	27.03	5433	146858	.0285 (N-S) -6.45 (E-W) 4.281 ACCIDENTAL	-73.71	-.056	9.46	8.43	132.8	141.2	197.7
D	27.03	5433	146858		73.71	+.056	-9.46	8.43	132.8	141.2	197.7
	54.06										
A	34.25	2985.5	102254		-54.64	-.053	12.07	7.92	97.0	109.1	152.7
C	59.52	1186.8	70638		34.45	+.058	-9.74	8.68	168.6	177.3	248.2
	93.77		Σ=466608								

M_T (N-S) = 265.63 × .05 = +13.28 $^{\underline{IK}}$

M_T (E-W) = 265.63 × -11.34 = -3012.2 $^{\underline{IK}}$

ACCIDENTAL TORSION = 265.63 × .05 × 148.66 = ± 1974.4 $^{\underline{IK}}$

* FACTORED DESIGN LOAD = 1.4 (DESIGN LOAD)

1^{ST} STORY (2^{ND} FLOOR DIAPHRAGM)

WALL	K	d^2	Kd^2	$\frac{M_T}{\Sigma Kd^2} \times 10^3$	÷ d	S_{N-S}	S_{E-W}	$S_{ACCID.}$	K LOAD	DESIGN LOAD	FACTORED DESIGN LOAD
B	27.03	5433	146858	.453 (N-S) -1.317 (E-W) ± 8.381 ACCIDENTAL	-73.71	-.90	2.62	16.70	300.3	317.0	443.8
D	27.03	5433	146858		73.71	+.90	-2.62	16.70	300.3	317.0	443.8
	54.06										
A	62.50	1974	123377		-44.43	-1.26	3.66	23.27	290.6	313.9	439.4
C	66.67	1734	115598		41.64	+1.26	-3.66	23.27	310.0	333.3	466.6
	129.17		Σ = 532691								

M_T (N-S) = (265.63 × .05) + (335 × .69) = 244.4 $^{\underline{IK}}$

M_T (E-W) = (265.63 × 5.89) + (335 × 5.94) = -3554.5 $^{\underline{IK}}$

ACCIDENTAL TORSION = 600.63 × .05 × 148.66 = ± 4464.5 $^{\underline{IK}}$

SEISMIC ANALYSIS

SYMBOLS (FOR SHEET AM-E18)

K = RELATIVE WALL STIFFNESS

d = DISTANCE BETWEEN CENTER OF WALL AND CENTER OF RIGIDITY IN FEET.

M_T = TORSIONAL MOMENT = STORY SHEAR TIMES DISTANCE BETWEEN CENTER OF MASS AND CENTER OF RIGIDITY (CONSIDERED IN EACH DIRECTION AND FOR ACCIDENTAL TORSION).

S_{N-S} = SHEAR TO WALL DUE TO TORSION FROM NORTH-SOUTH SEISMIC.

S_{E-W} = SHEAR TO WALL DUE TO TORSION FROM EAST-WEST SEISMIC.

$S_{ACCID.}$ = SHEAR TO WALL DUE TO TORSION FROM ACCIDENTAL TORSION.

K LOAD = LOAD TO WALL BASED ON RELATIVE STIFFNESS

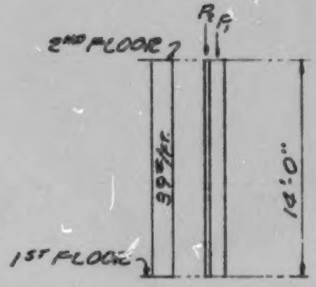
DESIGN LOAD = K LOAD PLUS THE GREATER OF ACCIDENTAL TORSION OR TORSION DUE TO LATERIAL LOADS IN THE DIRECTION OF THE WALLS.

AM-E20

WALL ANALYSIS - NORMAL FORCES

EARTHQUAKE

CHECK A PANEL FOR FORCES NORMAL TO WALL. SINCE THE BUILDING HAS A COMPLETE VERTICAL LOAD-CARRYING SPACE FRAME, THE ONLY VERTICAL LOAD IS THE WEIGHT OF THE WALL PLUS PRECAST CONCRETE VENEER WALL PANELS (MOSAI)



$C_p = 0.20$

$F_p = 2\,C_p\,W_p$

10" CONCRETE WALL = 124.5 #/□'

2½" MOSAI = 31.3 #/□'

155.8 #/□'

$f'_c = 2500$ p.s.i. $f_y = 40{,}000$ p.s.i. $n = 10$

$V = 0.9D + 1.4E$

$F_p = 1.25 \times .2 \times 155.8 = 38.95$ #/□'

P_1 (WALL) = 124.5 × 7 = 871.5#

P_2 (MOSAI) = 31.3 × 7 = 219.1

1090.6# = P

$P_u = .9 \times 1090.6 = 981.5$#

M (MOSAI) = 219.1 × 6.25 = 1369.4"# × .9 = 1232.5

$$M(\text{SEISMIC}) = \frac{39 \times 14'^{2}}{8} = 956\,\# \times 12 = 11466''\# \times 1.4 = \underline{16052.4}$$

17284.9"#

REINFORCING #4 @ 20" o.c. $p = \frac{A_s}{bd} = \frac{.20}{1.67 \times 12 \times 8.5} = .0012$

$np = 10 \times .0012 = .012$ $\quad 2/kj = 14.65 \quad A_s = \frac{.20}{1.67} = 0.12$ □"/'

p MIN. = $\frac{200}{40000} = .005 > .0012$ ∴ A_s REQ. = 1.33 A_s

$$A_s = \frac{M_u}{\phi f_s j d} = \frac{17285}{.9 \times 40000 \times .875 \times 8.5} = .065\,\square'' \times 1.33 = .086\,\square''$$

STRESS RATIO = $\frac{.086}{.12} = 0.72$ (FLEXURAL TENSION)

$$f_m = \frac{M_u}{\phi b d^2}\left(\frac{2}{kj}\right) = \frac{17285}{.7 \times 12 \times (8.5)^2} \times 14.65 = 417.2 \text{ p.s.i.}$$

$$f_a = \frac{P}{\phi A} = \frac{981.5}{.7 \times 12 \times 10} = 11.7 \text{ p.s.i.}$$

+417.2

428.9 p.s.i.

STRESS RATIO = $\frac{428.9}{2500} = 0.17$ (FLEXURAL COMPRESSION)

B. Wind

In this example, the critical elements to be determined for resisting wind forces are the wall piers and the floor and roof diaphragms. The assumed Basic Wind Speed is 100 mph with Exposure "C." No wind calculations were found. Earthquake calculations had been made and were of assistance, since a ratio of the design base shear for earthquake to total wind forces could be obtained.

The computations shown for this example are limited to the determination of wind forces and the distribution of these forces to the building, determining the critical elements and the critical stress ratio so that a final wind rating can be given.

From 1972 ANSI [3.2], Table 5, Exposure C, an effective velocity pressure, q_F, of 33 psf for a height of 30 feet is obtained. From table 7 the positive pressure coefficient on the windward side is 0.8 and the negative pressure coefficient on the leeward side is 0.5 for the ratio of wall height to least width less than 2.5. The total horizontal wind force on the building therefore is 1.3 times q_F. A suction coefficient of .7 for side walls is used. This is taken from 1972 ANSI [3.2, Paragraph 6.5.3.2.].

A plan of the roof with computed horizontal wind forces and reactions at roof level is shown on Calculation Sheet W2. The loads are determined using as tributary wind area one-half the story height (second floor to roof) plus the parapet. A similar computation is made for forces tributary to the second floor and these wind forces are shown on Sheet W5.

Uplift is computed on the narrow concrete projecting canopies. The coefficient of -1.25 is taken from 1973 UBC, [2.5, Section 2308 (c)]. The uplift is less than the dead load, thus, having all the reinforcing bars in the top is not critical. However, it would not fall off the building because the anchorage of the reinforcing steel would prevent this. This canopy is not a critical element in the evaluation of the building as a whole.

With the wind loads to the building as a whole determined, the shear walls are checked next. In section 4.4A, the relative stiffnesses of these walls have been computed and the total seismic force at each level determined. The ratio of wind forces to the seismic forces is computed. In the second story this ratio is 0.257 in the north-south direction and 0.151 in the east-west direction. Similar ratios are developed for the first story. The shear capacity is determined and compared with factored wind shears.

A typical wall panel had been checked for tornado forces normal to the wall. This is shown on Calculation Sheet AM-T9. Since the wind forces are less than the tornado forces, a calculation for wind was not considered necessary. However, a check of the wind pressure was made of wall corners using a coefficient of -2.0 (1972 ANSI, Paragraph 6.5.3.1) showing that this was less than the tornado pressure.

The Critical Stress Ratio is determined to be 0.26 for the second story corner piers 1 and 4, Walls B and D.

In filling out Form AMC-2 for "Other Life Hazards," some computations would normally be made. In this example the window frame anchorage, according to the architectural details on the original design drawings consists of 3/8 bolts at 2 ft on center. This gives only about 7 sq ft of window per anchor. This is obviously satisfactory so no written calculation was made; however, the Critical Stress Ratio would be less than 1.

The only wall cladding is a thin exposed aggregate precast concrete veneer that was used as a form for the poured concrete. The bond in this case should be adequate. Steel anchors are also used at the floor line however, and the Critical Stress Ratio would be less than 1.

There is a small area of granite facing near the entrance. This is a thin 7/8 in veneer applied with adhesive which is considered adequate. The usual requirement for this type of adhesive is 50 p.s.i. in tension or shear. Since a visual examination revealed no deterioration of this veneer or the veneer joints, the veneer is considered adequately attached to the wall.

Computations were made on the exposed walls and the canopy as previously noted, including the Critical Stress Ratios.

FACILITY NO. R.C. BUILDING

APPROXIMATE ANALYTICAL METHOD
STRUCTURAL SYSTEMS - WIND RATING

BUILDING DESIGNATION:

Exposure A,B,or C	Basic Wind Speed* V_1	Building Height	Effective Velocity Pressure q_F	Design Unit Pressure q_Fx1.4=P or q_Fx1.3=P	Critical Elements		Critical Stress Ratio f_w/f_a	Basic Wind Speed Capacity V_2 = $V_1\sqrt{f_a/f_w}$
					Type	Location		
C	100	31'-8¼"	33	1.3 × 33 = 42.9	SHEAR WALL	CORNER PIERS WALLS 8 & 10 (SHT. AM-W5 & W7	.26	196
			22	1.3 × 22 = 28.6		CORNER STRIP ALL WALLS (SHT AM-W9)	.94	

*See ANSI A58.1-72

f_w = Stress resulting from design pressures.

f_a = Allowable Material stress (x 1.33 where applicable)

NOTE: For rating of Structural Systems, use Form AME.

FACILITY NO. R.C. BUILDING

FORM AMC-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - WIND RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING
Glass Breakage*	------	COMPLIANCE
Glazing*	------	COMPLIANCE
Window Frame Anchorage	<1.0	GOOD
Wall Cladding Anchorage	<1.0	GOOD
Anchorage of Exterior Appendages	------	
Exposed Walls	<1.0	GOOD
Canopies and Eaves	.81	GOOD

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE*

TYPE	QUANTITY	DISTANCE
LUMBER YARD	LARGE	400'

*See Instructions for ratings.

CRITICAL STRESS RATIO	RATING
< 1.0	Good
1.0 to 1.5	Fair
> 1.5	Poor

AM-W1

DESIGN CRITERIA

LOAD CRITERIA

ROOF DEAD LOADS

5 PLY ROOFING + GRAVEL = 7.0 p.s.f.
JOISTS = 72.0
BEAMS = 9.0
CEILING = 10.0
98.0 p.s.f.

CONCRETE WALLS 150 p.c.f.
2½" PRECAST CONCRETE VENEER = 31.25 p.s.f.

ROOF LIVE LOAD = 20.0 p.s.f.

WIND CRITERIA (ANSI A58.1-1972)

EFFECTIVE VELOCITY PRESSURE q_F FOR BASIC WIND SPEED 100 m.p.h. AT 30 ft ELEVATION FOR EXPOSURE C = 33 p.s.f. (TABLE 5)

EXTERNAL PRESSURE COEFFICIENTS FOR WALLS, C_p
WINDWARD WALL 0.8
LEEWARD WALL 0.5
TOTAL DESIGN WIND LOAD = 1.3 (TABLE 7)

UPLIFT PRESSURE COEFFICIENT ON ROOF = -0.7 (SECT. 6.5.3.2.1)
WALLS - LOCAL PRESSURE COEFFICIENT = - 2.0 (SECT. 6.5.3.1)

FROM UBC 1973

UPLIFT PRESSURE COEFFICIENT FOR CANOPIES = -1.25 (SECT. 2308(c))

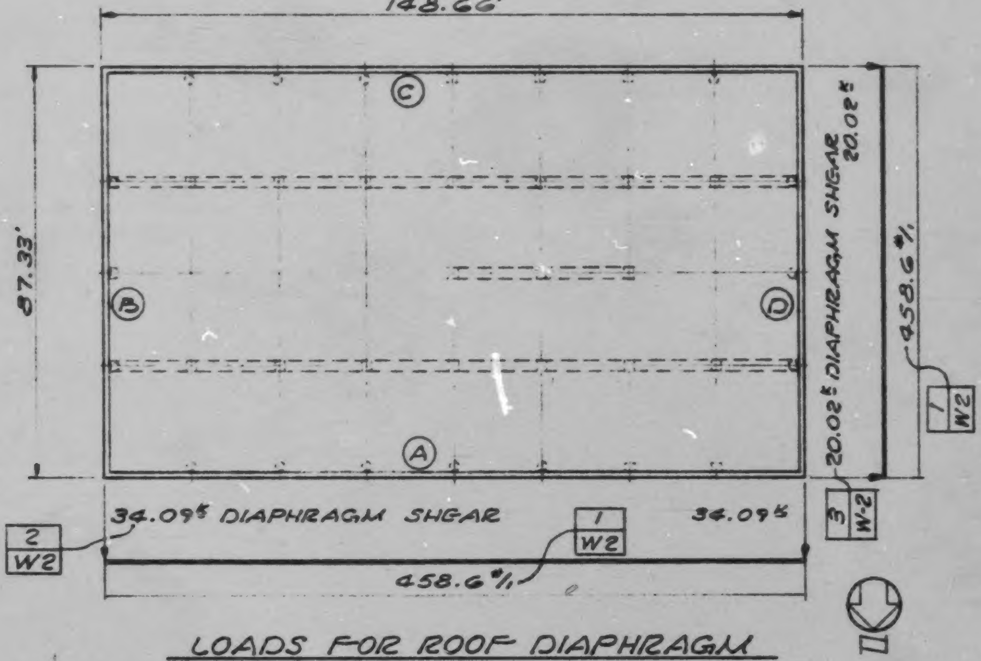
FROM ACI 318-71

REQUIRED STRENGTH $U = 0.9D + 1.3W$

DESIGN CRITERIA

(FROM THE PLANS AND SPECIFICATIONS)
CONCRETE f'_c = 2500 p.s.i.
REINFORCING STEEL f_y = 40,000 p.s.i.
ALLOWABLE SOIL PRESSURE = 1800 p.s.f. (DEAD + LIVE)

ROOF WIND ANALYSIS


148.66'
87.33'
C
B
D
A
20.02k DIAPHRAGM SHEAR 20.02k
458.6#/l
1
W2
3
W-2
34.09k DIAPHRAGM SHEAR
34.09k
2
W2
1
W2
458.6#/l

LOADS FOR ROOF DIAPHRAGM

ELEVATION PARAPET = 31'-8¼"
ELEVATION ROOF = 28'-0"
ELEVATION 2ND FLOOR = 14'-0"
BASIC PRESSURE = 33 p.s.f.
PRESSURE COEFFICIENT WINDWARD SIDE = 0.8
PRESSURE COEFFICIENT LEEWARD SIDE = 0.5
1.3

WALL TRIBUTARY TO ROOF
PARAPET = 3.69
FLOOR TO FLOOR
= 14.0' ÷ 2 = 7.00
10.69 ft.

FORCE AT THE ROOF LEVEL

$10.69 \times 1.3 \times 33 = 458.6$ p.l.f.

$4586 \times \frac{148.66}{2} = 34.09$ KIPS $\boxed{\frac{2}{W\text{-}2}}$ $.4586 \times \frac{87.33}{2} = 20.02$ KIPS $\boxed{\frac{3}{W2}}$

UPLIFT ON ROOF = $33 \times .70 = 23.1$ p.s.f.
ROOF D.L. = 98 p.s.f. ∴ NO NET UPLIFT
CONCRETE CANOPY UPLIFT = $33 \times 1.25 = 41.25$ p.s.f.
CONCRETE CANOPY D.L. = $56.25 \times .9 = 50.63$ p.s.f.
∴ NO NET UPLIFT
(NON CRITICAL ELEMET)

AM-W3

ROOF WIND ANALYSIS

CHECK ROOF DIAPHRAGM SHEAR (7½" × 16" JOIST + 2½" SLAB)

WIND LOAD = 34.09^{K} (SHEET AM-W1)

LOAD FACTOR FOR WIND = 1.3

$V_u = 1.3 \times 34.09 = 44.3$ KIPS

$$v_u = \frac{44300}{.85 \times 2.5 \times (87.33 \times 12 \times .8)} = 24.9 \text{ p.s.i.}$$

$v_{c\,ALLOW.} = 2\sqrt{2500} = 100$ p.s.i.

STRESS RATIO = $\frac{f_w}{f_a} = \frac{24.9}{100} = 0.25$ (SHEAR)

CHORD STRESS

$$M = \frac{.4586 \times (148.66)^2}{8} = 1266.9^{'K} \qquad T = \frac{1266.9 \times 1.3}{86.5} = 19.0 \text{ KIPS}$$

$A_s = \frac{19}{.9 \times 40} = 0.53$ SQ.IN. (SHEET AM-E9 $A_s = 2.20$)

STRESS RATIO = $\frac{0.53}{2.20} = 0.24$ (FLEXURAL TENSION)

CHECK WALL PIERS 2ND STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

NORTH - SOUTH

TOTAL WIND LOAD = 2 × 34.09 = 68.18 KIPS (SHEET W2)

COMPARE WITH SEISMIC ANALYSIS FOR METHOD

SEISMIC LOAD = 265.63 KIPS (SHEET AM-E4)

RATIO WIND TO SEISMIC = $\frac{68.18}{265.63} = 0.257$

FACTOR FOR FLEXURE = $0.257 \times \frac{1.3}{1.4} = .239$

FACTOR FOR SHEAR = $0.257 \times \frac{1.3}{2.8} = .119$

(U.B.C. SECTION 2609(d) AND 2627(a))

WALL B & D

PIER 1 & 4 2-#7 JAMB BARS = 1.20 SQ.IN. (FROM PLANS)

SEISMIC $A_s = 1.28$ SQ.IN. $v_u = 237$ p.s.i. (SHEET AM-E6)

WIND $A_s = 1.28 \times .239 = 0.31$ SQ.IN.

STRESS RATIO = $\frac{0.31}{1.20} = 0.26$ (FLEXURAL TENSION)

ROOF WIND ANALYSIS

CHECK WALL PIERS 2ND STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR (CONT.)

WALL B & D (CONT.)

WIND $v_u = 237 \times .119 = 28.2$ p.s.i.

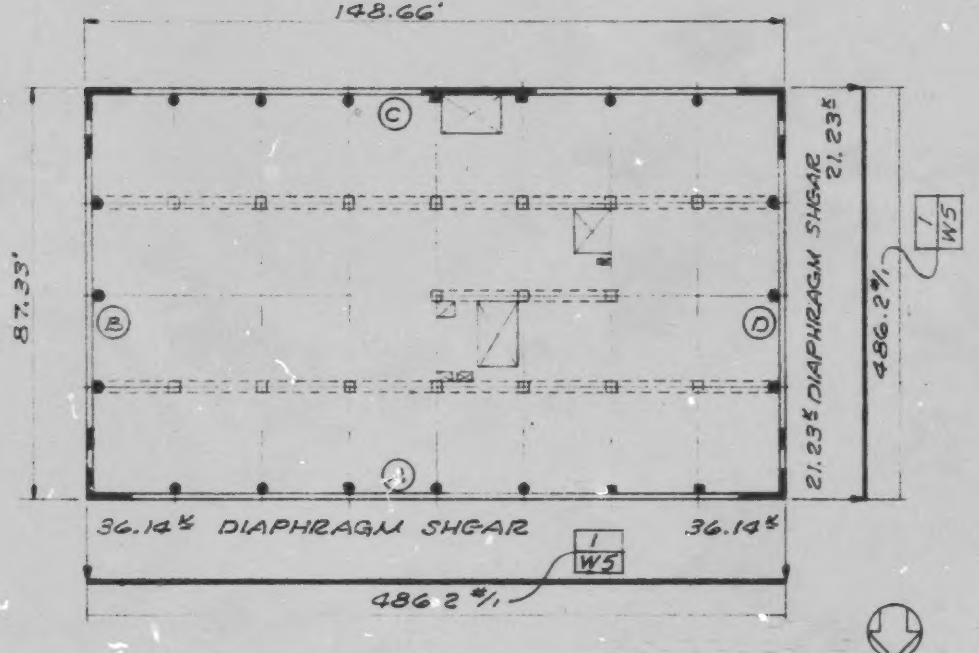
STRESS RATIO $= \frac{28.2}{180} = 0.157$ (SHEAR)

180 p.s.i. = ALLOWABLE v_u FOR 10" CONCRETE WALLS REINFORCED WITH #4 @ 20" o.c. B.W. B.F. (SHEET AM-E6)

THESE WERE THE ONLY CRITICAL 2ND STORY WALLS AND PIERS FOR EARTHQUAKE LOAD SINCE THE WIND LOAD IS LESS THAN THE EARTHQUAKE LOAD. THE REMAINING WALLS AND PIERS DO NOT REQUIRE CHECKING.

AM-W5

SECOND FLOOR WIND ANALYSIS


148.66'
87.33'
C
B
D
21.23k DIAPHRAGM SHEAR 21.23k
486.2#/l
1/W5
36.14k DIAPHRAGM SHEAR 36.14k
486 2#/l
1/W5

LOADS FOR 2ND FLOOR DIAPHRAGM

100 M.P.H. WIND EXPOSURE C

ELEVATION ROOF = 28'-0"
ELEVATION 2ND FLOOR = 14'-0"

WALL TRIBUTARY TO 2ND FLOOR
= 14'-0"

FORCE AT THE SECOND FLOOR LEVEL

6' AT 33#/□' = 198
8' AT 22#/□' = 176
1.3 x 374#/l = 486.2 p.l.f. 1/W5

UPLIFT CONCRETE CANOPY. 22 x 1.25 = 27.5 p.s.f.
CANOPY D.L. = 56.25 x .9 = 50.63 p.s.f. } ∴ NO NET UPLIFT
CANOPY D.L. = 67.7 x .9 = 60.9 p.s.f. } (NON CRITICAL ELEMENT)

DIAPHRAGM SHEAR $= .4862 \times \frac{148.66}{2} = 36.14$ KIPS

$.4862 \times \frac{87.33}{2} = 21.23$ KIPS

SECOND FLOOR WIND ANALYSIS

CHECK WALL PIERS 1ST STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

NORTH-SOUTH

TOTAL WIND LOAD = 2 × 36.14 = 72.28 KIPS (SHEET AM-W5)
+68.18 (SHEET AM-W3)
V_2 = 140.46 KIPS

COMPARE WITH SEISMIC ANALYSIS FOR METHOD

SEISMIC LOAD V_2 = 600.6 KIPS (SHEET AM-E11)

RATIO WIND TO SEISMIC = $\frac{140.46}{600.6} = 0.233$

FACTOR FOR FLEXURE = $0.233 \times \frac{1.3}{1.4} = 0.216$

FACTOR FOR SHEAR = $0.233 \times \frac{1.3}{2.8} = 0.108$

WALL B & D

PIER 1 & 4 2-#10 JAMB BARS EXISTING = 2.54 SQ. IN.

SEISMIC A_s = 3.0 SQ. IN. v_u = 531.9 p.s.i. (SHEET AM-E14)

WIND A_s = 3 × .216 = 0.65 SQ. IN.

STRESS RATIO = $\frac{0.65}{2.54} = 0.26$ (FLEXURAL TENSION)

WIND v_u = 531.9 × .108 = 57.4 p.s.i.

STRESS RATIO = $\frac{57.4}{180} = 0.319$ (SHEAR)

PIER 2 & 3 2-#10 JAMB BARS EXISTING = 2.54 SQ. IN.

SEISMIC A_s = 1.99 SQ. IN. v_u = 343.1 p.s.i. (SHEET AM-E14)

WIND A_s = 1.99 × .216 = 0.43 SQ. IN.

STRESS RATIO = $\frac{0.43}{2.54} = 0.17$ (FLEXURAL TENSION)

WIND v_u = 343.1 × .108 = 37.1 p.s.i.

STRESS RATIO = $\frac{37.1}{180} = 0.21$ (SHEAR)

SECOND FLOOR WIND ANALYSIS

CHECK WALL PIERS 1ST STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

EAST-WEST

TOTAL WIND LOAD = 2 × 20.02 = 40.04 (SHEET AM-W2)
+ 2 × 21.23 = 42.46 (SHEET AM-W5)
V_2 = 82.50 KIPS

COMPARE WITH SEISMIC ANALYSIS FOR METHOD
SEISMIC LOAD V_2 = 600.6 KIPS (SHEET AM-E11)

RATIO WIND TO SEISMIC = $\frac{82.5}{600.6}$ = 0.137

FACTOR FOR FLEXURE = 0.137 × $\frac{1.3}{1.4}$ = 0.127

FACTOR FOR SHEAR : 0.137 × $\frac{1.3}{2.8}$ = 0.064

WALL A

PIER 1 & 4 2-#7 JAMB BARS EXISTING = 1.20 SQ. IN.
SEISMIC A_s = 1.43 SQ. IN. v_u = 261.5 (SHEET AM-E14 & E15)
WIND A_s = 1.43 × .127 = 0.18 SQ. IN.
STRESS RATIO = $\frac{0.18}{1.20}$ = 0.15 (FLEXURAL TENSION)
WIND v_u = 261.5 × .064 = 16.7 p.s.i.
STRESS RATIO = $\frac{16.7}{180}$ = 0.09 (SHEAR)

WALL C

PIER 1 & 4 2-#7 JAMB BARS EXISTING = 1.20 SQ. IN.
SEISMIC A_s = 1.36 SQ. IN. v_u = 249.3 p.s.i. (SHEET AM-E15 & E16)
WIND A_s = 1.36 × .127 = 0.17 SQ. IN.
STRESS RATION = $\frac{0.17}{1.20}$ = 0.14 (FLEXURAL TENSION)
WIND v_u = 249.3 × .064 = 16.0
STRESS RATIO = $\frac{16}{180}$ = .09 (SHEAR)

SINCE THE EARTHQUAKE ANALYSIS SHOWED THE OTHER PIERS TO BE NON CRITICAL, THE SMALLER WIND LOADS WOULD ALSO NOT OVER STRESS THE REMAINING PIERS.

SECOND FLOOR WIND ANALYSIS

CHECK SECTION OF WALL ALONG THE CORNER

FOR A VERTICAL STRIP OF WIDTH 0.1W = 0.1 × 87.33 = 8.73'
A PRESSURE COEFFICIENT - 2.0 IS USED: 33 × 2 = 66 p.s.f.

COMPARE WITH SEISMIC ANALYSIS ON SHEET AM-E20 FOR METHOD.

SEISMIC LOAD = 39 p.s.f.

RATIO OF WIND FORCE TO SEISMIC FORCE $= \frac{66}{39} = 1.69$

FACTOR FOR FLEXURE (LOAD FACTOR RATIO) $= 1.69 \times \frac{1.3}{1.4} = 1.57$

WIND f_m = 417.2 (SHEET AM-E20) × 1.57 = 655.0 p.s.i.
$+ f_a$ = 11.7 (SHEET AM-E20)
666.7 p.s.i.

STRESS RATIO $= \frac{666.7}{2500} = .27$ (FLEXURAL COMPRESSION)

A_s SEISMIS = .086 (SHEET AM-E20)

A_s WIND = 1.57 × .086 = 0.14 SQ. IN.

STRESS RATIO $= \frac{.14}{.12} = 1.17$ (FLEXURAL TENSION)

NOTE: THESE WALLS HAVE CONTINUITY WITH THE FOOTINGS AND THE 1ST AND 2ND FLOORS. THE MOMENT USED IN THE SEISMIC ANALYSIS (SHEET AM-E20) WAS $WL/8$ THEREFORE USE $WL/10$ THEN STRESS RATIO = 1.17 × .8 = 0.94 IN ADDITION THIS FORCE IS CONSIDERED ACTING AT A CORNER WHERE THE MOMENT OF INERTIA IS LARGER AND THE REQUIRED A_s SMALLER. THEREFORE THE ACTUAL STRESS RATIO IS DEFINITELY LESS THAN 1.0.

C. Tornado

For this example the building is assumed to be subject to tornado hazard with probability of occurrence once in a 100-year period.

No original computations for tornado hazards were available. The computations made for this example consist of the determination of tornado wind pressures, positive and negative, and the distribution of these forces to the building. A brief check is made on the probability of glass breakage and window frame anchorage. The anchorage of the thin precast concrete veneer panels is considered satisfactory. The elements felt to be probably the most critical were the roof framing elements subjected to negative or uplift pressure and the shear walls subjected to horizontal pressure. The critical stress ratios of these elements were computed.

As noted in Section 3.3 under "Criteria for the Method," the suction or uplift on the roof for moderate tornado protection is assumed to be 172 psf and the horizontal velocity pressure is assumed to be 100 psf. In this building the height/width ratio is less than 2.5, so the windward and leeward coefficients will be 0.8 and 0.5, respectively. Calculation Sheet T3 computes the total uplift on the building. The horizontal force loading diagram is shown for loads applied at the roof level on Sheet T2. On sheet T4, the uplift on the individual roof concrete joists and girders is acceptable. Since the uplift on these members is greater than the dead load, these members are checked in detail since these are potential critical members.

Since computations for this example have already been made for earthquake and the distribution of lateral forces to the various shear walls and piers determined, it was not necessary to repeat this for tornado. A ratio of tornado forces to seismic forces is computed at each level and these ratio factors used in determining the critical stress ratios shown on Sheets T5, T7 and T8 for vertical resisting elements.

A typical wall panel is checked for direct normal pressure on Sheet T9. The maximum diaphragm shear from tornado forces is shown on Sheet T5.

The anchorage of the roof to the walls is accomplished by the vertical wall steel and column bars. This is calculated on Sheet T3.

Since there was no net uplift on the structure, the footings and footing anchorage critical stress ratios are listed as less than 0.46, the critical ratio of uplift forces alone.

The glass and glazing items listed under "Other Life Hazards" are rated as "Compliance" with normal wind requirements. It is known from experience that such normal compliance will not prevent damage in a tornado. However, the window frame anchorage was found to be reasonably adequate.

FACILITY NO. R.C. BUILDING

FORM AMD-1

APPROXIMATE ANALYTICAL METHOD
RATING FORM - TORNADOES

SYSTEMS CRITICAL STRESS RATIOS*

SYSTEM	f_T/f_a **
Roof	1.10
Roof Anchorage	.44
Floor	.76
Floor Anchorage	<1.0
Vertical Resisting Element	.83
Anchorage to Footings	< .46
Footings	<.46

*Use highest Critical Stress Ratio.
For Structural Systems Rating - Tornado, see Form AME.

**f_T = Capacity required to resist tornado forces.
f_a = Capacity based on design criteria.

FACILITY NO. R.C. BUILDING FORM AMD-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - TORNADO RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING
Glass Breakage*	------	COMPLIANCE
Glazing*	--------	COMPLIANCE
Window Frame Anchorage	<2.0	GOOD
Wall Cladding Anchorage	<2.0	GOOD
Anchorage of Exterior Appendages	--------	
Exposed Walls	1.34	GOOD
Canopies & Eaves	3.40	POOR

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE*

TYPE	QUANTITY	DISTANCE
LUMBER YARD	LARGE	400'

*See Instructions for ratings.

CRITICAL STRESS RATIO	RATING
< 2.0	Good
2.0 to 3.0	Fair
> 3.0	Poor

DESIGN CRITERIA

LOAD CRITERIA

ROOF DEAD LOADS

5 PLY ROOFING + GRAVEL = 7.0 p.s.f.
JOISTS = 72.0
BEAMS = 9.0
CEILING = 10.0
98.0 p.s.f.

CONCRETE WALLS = 150 p.c.f.
2½" PRECAST CONCRETE VENEER = 31.25 p.s.f.

ROOF LIVE LOADS = 20.0 p.s.f.

TORNADO CRITERIA

EFFECTIVE VELOCITY PRESSURE q_F FOR TORNADO = 100 p.s.f.

EXTERNAL PRESSURE COEFFICIENTS FOR WALLS, C_p

WINDWARD WALL = 0.8
LEE-WARD WALL = 0.5
TOTAL DESIGN TORNADO = 1.3

UPLIFT PRESSURE ON ROOF = 172 p.s.f.

FROM ACI 318-71

REQUIRED STRENGTH $U = 0.9D + 1.3W$

WHERE THE SPECIFIED TORNADO LOADS = 1.3 W

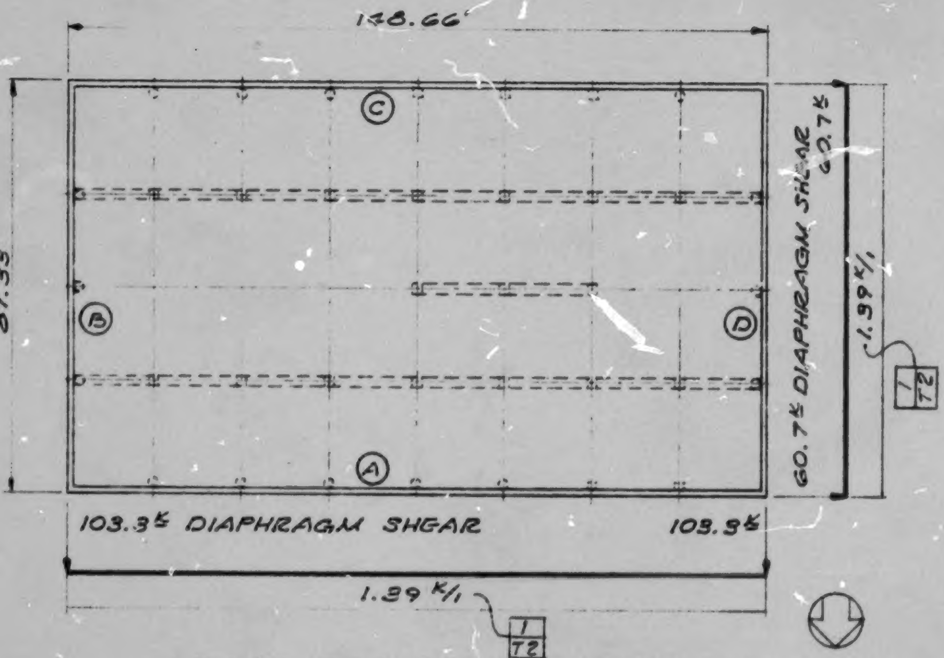
DESIGN CRITERIA (FROM THE PLANS & SPECIFICATIONS)

CONCRETE f'_c = 25000 p.s.i.

REINFORCING STEEL f_y = 40,000 p.s.i.

ALLOWABLE SOIL PRESSURE = 1800 p.s.f. (DEAD + LIVE)

ROOF TORNADO ANALYSIS


148.66'
87.35'
C
B
D
A
60.7k DIAPHRAGM SHEAR
60.7k
1.39 k/l
1/T2
103.3k DIAPHRAGM SHEAR
103.3k
1.39 k/l
1/T2

LOADS FOR ROOF DIAPHRAGM

TORNADO FORCES

UPLIFT = 172 #/□'
HORIZONTAL = 1.3 × 100 = 130 p.s.f
DIAPHRAGM = 10.69 × 130 = 1390 p.l.f 1/T2

DIAPHRAGM SHEAR

$$1.39 \times \frac{148.66}{2} = 103.3 \text{ KIPS}$$

$$1.39 \times \frac{87.33}{2} = 60.7 \text{ KIPS}$$

WALL TRIBUTARY TO ROOF

PARAPET = 3.69
FLOOR TO ROOF = 14 ÷ 2 = 7.00
10.69 ft.

ROOF TORNADO ANALYSIS

CHECK ROOF DIAPHRAGM SHEAR
(7½" x 16" JOISTS + 2½" SLAB)

TORNADO LOAD = 103.3 KIPS (SHEET AM-T2)

V_u = 103.3 KIPS

$$v_u = \frac{103,300}{.85 \times 2.5\,(87.33 \times 12 \times .8)} = 58.0\ \text{p.s.i.}$$

STRESS RATIO = $\frac{58.0}{100}$ = 0.58 (SHEAR) ($v_{c\ \text{ALLOW.}}$ = 100 p.s.i. SHEET AM-W3)

CHORD STRESS

$M = 1.39 \times (148.66)^2 \div 8 = 3839.8$ FT. KIPS

$$T = \frac{3839.8}{86.5} = 44.4\ \text{KIPS}$$

$$A_s = \frac{44.4}{.9 \times 40} = 1.23\ \text{SQ. IN.}$$

STRESS RATIO = $\frac{1.23}{2.20}$ = 0.56 (FLEXURAL TENSION) (SHEET AM-E9)

CHECK TORNADO UPLIFT ON ROOF

TOTAL UPLIFT ON ROOF = .172 p.s.f. x 87.33 x 148.66 = 2233.0 KIPS

DEAD LOAD RESISTANCE TO UPLIFT

ROOF = 0.9 x .098 x 87.33 x 148.66 = 1145.1

WALLS A = 222.08
B = 132.99
C = 234.51
D = 132.99
} (SHEET AM-E10)
722.57 x .9 = 650.3

1795.4 KIPS

APPROXIMATE RESISTANCE BY REINFORCEMENT

INTERIOR COLUMNS 4-#9 = 4.0 x 17 = 68.0 SQ. IN.

EXTERIOR COLUMNS 4-#7 = 2.4 x 20 = 48.0 SQ. IN.

116.0 SQ. IN.

.9 x 116.0 x 40 K.S.I. = 4176.0

TOTAL RESISTANCE = 5971.4 KIPS

$$\text{STRESS RATIO} = \frac{f_r}{f_a} = \frac{2233}{5971.4} = .37$$

FROM EARTHQUAKE ANALYSIS THE WEIGHT OF THE BUILDING, EXCEPT FOR WALLS AND FOOTINGS BELOW MID 1ST STORY HEIGHT = 2125 + 2680 = 4805 KIPS (DEAD LOAD) (SHEET AM-E2 & AM-E10)

UPLIFT = 2233 KIPS ∴ THERE IS NO NET UPLIFT ON THE BUILDING AS A WHOLE.

ROOF TORNADO ANALSIS

CHECK TORNADO UPLIFT ON ROOF (CONT.)

CHECK UPLIFT ON JOISTS

JOIST SPACING = 3.2'

UPLIFT ON JOIST = 0.172 K.P.S.F.

DEAD LOAD JOIST .072 × .9 = 0.065

NET UPLIFT = 0.107 × 3.2 = 0.342 K.P.L.F.

$-M = \frac{.342 \times (19.75)^2}{10} = 13.34^{\underline{1K}}$

$+M \text{ EXTERIOR} = \frac{.342 \times (22)^2}{14} = 11.82^{\underline{1K}}$

MINIMUM JOIST REINFORCING = 2-#5 BARS BOTTOM = 0.62 SQ. IN.
2-#4 BARS TOP = 0.40 SQ. IN.

$-f_s = \frac{13.34 \times 12}{.62 \times .875 \times 17} = 17.36$ K.S.I.

STRESS RATIO = $\frac{17.36}{40} = 0.43$ (FLEXURAL TENSION)

$+f_s = \frac{11.82 \times 12}{.40 \times .875 \times 17} = 23.83$ K.S.I.

STRESS RATIO = $\frac{23.83}{40} = .72$ (FLEXURAL TENSION)

CHECK UPLIFT ON GIRDERS

GIRDER SPAN = 18.33' (TYPICAL INTERIOR EAST-WEST GIRDERS)

MINIMUM GIRDER REINFORCING = 2-#10 BOTTOM = 2.54 SQ. IN.
2-#4 TOP = 0.40 SQ. IN.

TORNADO UPLIFT = 172.0 P.S.F.

DEAD LOAD JOIST + GIRDERS = 91 × .9 = 81.9 P.S.F.

(72 + 9 + 10 = 91 P.S.F.) (SHEET AM-T1) 90.1 P.S.F. NET UPLIFT

TRIBUTARY = $\frac{(21.5 + 18.33)}{2} = 19.9'$

UPLIFT LOAD TO GIRDER = 19.9 × 90.1 = 1792 P.L.F.

$-M = \frac{1.79 \times (17.33)^2}{10} = 53.8^{\underline{1K}}$ $\quad f_s = \frac{53.8 \times 12}{2.54 \times .875 \times 26} = 11.2$ K.S.I.

STRESS RATIO = $\frac{11.2}{40} = 0.28$ (FLEXURAL TENSION)

$+M = \frac{1.79 \times (17.33)^2}{16} = 33.6^{\underline{1K}}$ $\quad f_s = \frac{33.6 \times 12}{.4 \times .875 \times 26} = 44.3$ K.S.I.

STRESS RATIO = $\frac{44.3}{40} = 1.1$ (FLEXURAL TENSION)

ROOF TORNADO ANALYSIS

CHECK WALL PIERS 2ND STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

NORTH - SOUTH

TOTAL TORNADO LOAD = 2 × 103.3 = 206.6 KIPS (SHEET AM-T2)

COMPARE WITH SEISMIC ANALYSIS FOR METHOD

SEISMIC LOAD = 265.63 KIPS × 1.4 = 371.9 (SHEET AM-E4)

RATIO OF TORNADO TO SEISMIC $= \frac{206.6}{371.9} = 0.56$

FACTOR FOR FLEXURE = 0.56

FACTOR FOR SHEAR $= \frac{.56}{2} = 0.28$

(U.B.C. SECTION 2609(d) AND 2627(a))

WALL B & D

PIER 1 & 4 2-#7 JAMB BARS = 1.20 SQ. IN (FROM PLAN)

SEISMIC $A_s = 1.28$ SQ. IN. $v_u = 237$ p.s.i. (SHEET AM-E6)

TORNADO $A_s = 1.28 \times .56 = 0.72$ SQ. IN.

STRESS RATIO $= \frac{f_r}{f_a} = \frac{0.72}{1.2} = 0.60$ (FLEXURAL TENSION)

TORNADO $v_u = 237 \times .28 = 66.4$ p.s.i.

STRESS RATIO $= \frac{f_r}{f_a} = \frac{66.4}{180} = .37$ (SHEAR)

(FOR $v_u = 180$ p.s.i. SEE SHEET AM-E6)

THESE WERE THE ONLY CRITICAL 2ND STORY WALLS FOR EARTHQUAKE LOAD. SINCE THE TORNADO LOAD IS LESS THAN EARTHQUAKE LOAD, THESE PIERS ARE ADEQUATE FOR TORNADO.

CHECK 2ND FLOOR DIAPHRAGM SHEAR

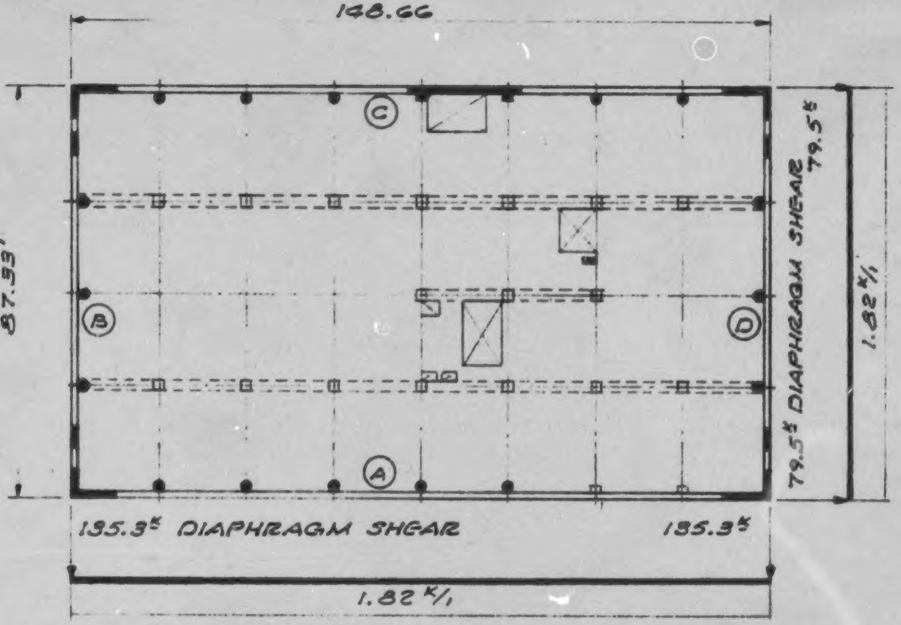
DIAPHRAGM SHEAR = 135.3 KIPS (SHEET AM-T6)

ROOF DIAPHRAGM SHEAR = 103.3 KIPS (SHEET AM-T2)

BY COMPARISON $v_u = \frac{135.3}{103.3} \times 58.0 = 75.9$ p.s.i.

STRESS RATIO $= \frac{75.9}{100} = .76$ (SHEAR)

SECOND FLOOR TORNADO ANALYSIS


148.66
Ⓒ
87.33'
Ⓑ
Ⓓ
Ⓐ
79.5k DIAPHRAGM SHEAR 79.5k
1.82 k/l
135.3k DIAPHRAGM SHEAR
135.3k
1.82 k/l

LOADS FOR 2ND FLOOR DIAPHRAGM

TORNADO FORCES

WALL TRIBUTARY = 14.0 ft.

HORIZONTAL = 1.3 × 100 = 130 p.s.f.

DIAPHRAGM = 14 × 130 = 1820 p.l.f.

DIAPHRAGM SHEAR

$$1.82 \times \frac{148.66}{2} = 135.3 \text{ KIPS}$$

$$1.82 \times \frac{87.33}{2} = 79.5 \text{ KIPS}$$

UPLIFT CONCRETE CANOPIES = 172.0

CANOPY D.L. = .375 × 150 = 56.25 × .9 = 50.63

NET UPLIFT = 121.37 p.s.f.

CANOPY D.L. = .45 × 150 = 67.5 × .9 = 60.9 p.s.f.

NET UPLIFT = 172 - 60.9 = 111.1 p.s.f.

$$\text{STRESS RATIO} = \frac{172}{50.63} = 3.40 \ \& \ \frac{172}{60.9} = 2.82$$

SECOND FLOOR TORNADO ANALYSIS

CHECK WALL PIERS 1ST STORY FOR FLEXURAL REINFORCEMENT AND UNIT SHEAR

NORTH - SOUTH

TOTAL TORNADO LOAD = 2 x 135.3 = 270.6 KIPS (SHEET AM-T6)
+ 206.6 (SHEET AM-T5)
V_2 = 477.2 KIPS

COMPARE WITH SEISMIC ANALYSIS FOR METHOD
SEISMIC LOAD V_2 = 600.6 KIPS (SHEET AM-E11) x 1.4 = 840.8

RATIO OF TORNADO TO SEISMIC $= \frac{477.2}{840.8} = 0.57$

FACTOR FOR FLEXURE = 0.57

FACTOR FOR SHEAR $= \frac{0.57}{2} = 0.29$

WALL B & D

PIER 1 & 4 2-#10 JAMB BARS EXISTING 2.54 SQ. IN.
SEISMIC A_s = 3.0 SQ. IN. v_u = 531.9 p.s.i. (SHEET AM-E14)
TORNADO A_s = 3 x .57 = 1.71
STRESS RATIO $= \frac{1.71}{2.54} = 0.67$ (FLEXURAL TENSION)
TORNADO v_u = 531.9 x .29 = 154.3
STRESS RATIO $= \frac{154.3}{180} = 0.86$ (SHEAR)

PIER 2 & 3 2-#10 JAMB BARS EXISTING = 2.54 SQ. IN.
SEISMIC A_s = 1.99 SQ. IN. v_u = 343.1 p.s.i. (SHEET AM-E14)
TORNADO A_s = 1.99 x .57 = 1.13 SQ. IN.
STRESS RATIO $= \frac{1.13}{2.54} = 0.45$ (FLEXURAL TENSION)
TORNADO v_u = 343.1 x .29 = 99.5 p.s.i.
STRESS RATIO $= \frac{99.5}{180} = 0.55$ (SHEAR)

SECOND FLOOR TORNADO ANALYSIS

EAST - WEST

TOTAL TORNADO LOAD = 2 × 79.5 = 159.0 KIPS (SHEET AM-T6)
+ 2 × 60.7 = 121.4 (SHEET AM-T2)
280.4 KIPS

COMPARE WITH SEISMIC ANALYSIS FOR METHOD
SEISMIC LOAD V_2 = 600.6 KIPS (SHEET AM-E11) × 1.4 = 840.8

RATIO TORNADO TO SEISMIC = $\frac{280.4}{840.8}$ = 0.33

FACTOR FOR FLEXURE = 0.33

FACTOR FOR SHEAR = $\frac{0.33}{2}$ = 0.17

WALL A

PIER 1 & 4 2-#7 JAMB BARS EXISTING = 1.20 SQ. IN.
SEISMIC A_s = 1.43 SQ. IN. v_u = 261.5 p.s.i. (SHEET AM-E12)
TORNADO A_s = 1.43 × .33 = 0.47 SQ. IN.

STRESS RATIO = $\frac{0.47}{1.20}$ = 0.39 (FLEXURAL TENSION)

TORNADO v_u = 261.5 × .17 = 44.5 p.s.i.

STRESS RATIO = $\frac{44.5}{180}$ = .25 (SHEAR)

WALL C

PIER 1 & 4 2-#7 JAMB BARS EXISTING = 1.20 SQ. IN.
SEISMIC A_s = 1.36 SQ. IN. v_u = 249.3 p.s.i. (SHEET AM-E13)
TORNADO A_s = 1.36 × .33 = .45 SQ. IN.

STRESS RATIO = $\frac{0.45}{1.20}$ = 0.37 (FLEXURAL TENSION)

TORNADO v_u = 249.3 × .17 = 42.4 p.s.i.

STRESS RATIO = $\frac{42.4}{180}$ = .24 (SHEAR)

SINCE THE EARTHQUAKE ANALYSIS SHOWNED THE OTHER PIERS TO BE NON CRITICAL THE SMALLER TORNADO LOADS WOULD ALSO NOT OVERSTRESS THE REMAINING PIERS.

SECOND FLOOR TORNADO ANALYSIS

CHECK SECTION OF WALL BETWEEN DIAPHRAGMS

COMPARE WITH SEISMIC ANALYSIS ON SHEET AM-E20 FOR METHOD

TORNADO LOAD = 0.80 × 100 = 80 p.s.f. (SHEET AM-T1)

SEISMIC LOAD = 39 p.s.f. × 1.4 = 54.6 p.s.f.

RATIO TORNADO TO SEISMIC = $\frac{80}{54.6} = 1.47$

TORNADO $f_m = 417.2$ (SHEET AM-E20) $\times 1.47 = 613.3$

$$\begin{array}{r} +f_a = \underline{11.7} \\ 625.0 \text{ p.s.i.} \end{array}$$

STRESS RATIO = $\frac{625}{2500} = 0.25$ (FLEXURAL COMPRESSION)

A_s SEISMIC = .086 (SHEET AM-E20)

A_s TORNADO = 1.47 × .086 = 0.13 SQ. IN.

STRESS RATIO = $\frac{.13}{.12} = 1.08$ (FLEXURAL TENSION)

WHILE $^{WL}/_{8}$ MOMENT WAS USED FOR SEISMIC ANALYSIS THE WALLS HAVE CONTINUITY WITH THE FOOTINGS AND 1ST AND 2ND FLOORS AND IS MORE LIKE $^{WL}/_{10}$. THEN STRESS RATIO = 1.08 × .8 = 0.86

D. Resume

Earthquake

The Approximate Analytical Evaluation Method gives this building a rating of "Very Poor" for the 9.5 Modified Mercalli Scale Intensity earthquake used for this site. This is an extremely high intensity and this building would rate better for earthquakes with a lower MMI.

The Exit Enclosure Walls are rated "Fair" to "Good." There is no problem with Partitions and Wall Cladding, but the Ceilings and Light Fixtures are not laterally braced and these Life Hazards are rated "Poor."

Wind

The Basic Wind Speed applicable to this site has been designated as 100 miles per hour, which is of hurricane velocity. The rating of the Structural System as a whole is "Good," however. There appears to be no problem with Other Life Hazards except that there is a potential hazard from windblown debris from the lumber yard 400 feet away.

Tornado

This building rates "Good" for Tornado hazard as far as the structural system as a whole is concerned. Because top reinforcing steel was provided in the concrete joists and girders, the roof was found capable of taking the uplift forces below ultimate strength of concrete or yield stress in the reinforcing steel. The diaphragm critical stress ratio is 1.0. The diaphragm shears here are the same as for Earthquake. There is a potential hazard from windblown missiles from the lumber yard 400 feet away.

FACILITY NO. R.C. BUILDING

FORM AME

APPROXIMATE ANALYTICAL METHOD
CRITICAL STRESS RATIOS - STRUCTURAL SYSTEMS

	Critical Stress Ratio	Rating
Earthquake	2.96	VERY POOR
Wind	0.94	GOOD
Tornado	1.10	GOOD

RATING OF CRITICAL STRESS RATIOS

Critical Stress Ratio	Earthquake or Wind	Tornado
Less than 1.0	Good	Good
1 to 1.5	Fair	Good
1.5 to 2.0	Poor	Good
2.0 to 3.0	Very Poor	Fair
3.0 to 4.0	Very Poor	Poor
Over 4.0	Very Poor	Very Poor

4.5 DETAILED ANALYTICAL EVALUATION METHOD

The same two-story reinforced concrete building evaluated by the Field Evaluation and the Approximate Analytical Evaluation Methods is evaluated in this section. It was assumed that the building is subjected to an earthquake of Richter magnitude of 7.0 with a hypocentral distance of 10 miles. This earthquake is equivalent to MMI of 9.54 according to equation (3.4.3). For wind and tornado load analysis, wind velocities of 100 and 200 miles per hour, respectively were used.

A listing of the computer program results is contained on the following pages.

FORTRAN IV COMPUTER PROGRAM LISTING

```
                EXAMPLE 1  TWO STORY CONCRETE SHEAR-WALL BUILDING

INCLUDE EARTHQUAKE HAZARD:    1

INCLUDE WIND HAZARD:          1

INCLUDE TORNADO HAZARD:       1

SITE LOCATION: LATITUDE   34.20  DEGREES, LONGITUDE  118.50  DEGREES

EXERCISE RISK OPTION:         0

BUILDING MODELING OPTION:       1

EVALUATE DAMAGE TO LONG-SPAN ROOF:     1



                 E A R T H Q U A K E  L O A D  A N A L Y S I S



HARD ROCK GROUND MOTION CHARACTERISTICS

          RICHTER MAGNITUDE              =   7.00+00
          HYPOCENTRAL DISTANCE (MILES) =   1.00+01
          HARD ROCK ACCELERATION (G)     =   1.37-01
          HARD ROCK VELOCITY (IN/SEC)    =   8.18+00
          HARD ROCK DISPLACEMENT (IN)    =   2.69+00



                   DEPTH TO WATER TABLE =   40.00
                   SOIL CODE. . . . . . =       2
```

```
BASE SPECTRUM IN TERMS OF THE MEAN AND   .00 STANDARD DEVIATIONS

PERIOD (SEC)      .10     .20     .30     .40     .50     .60     .70     .80     .90    1.00
PSV (IN/SEC)     2.36    4.72    7.09    9.45   11.81   14.17   16.54   18.90   21.26   22.95

PERIOD (SEC)     1.10    1.20    1.30    1.40    1.50    1.60    1.70    1.80    1.90    2.00
PSV (IN/SEC)    22.95   22.95   22.95   22.95   22.95   22.95   22.95   22.95   22.95   22.95

PERIOD (SEC)     2.10    2.20    2.30    2.40    2.50    2.60    2.70    2.80    2.90    3.00
PSV (IN/SEC)    22.57   21.54   20.61   19.75   18.96   18.23   17.35   16.93   16.34   15.80

PERIOD (SEC)     3.10    3.20    3.30    3.40    3.50    3.60    3.70    3.80    3.90    4.00
PSV (IN/SEC)    15.29   14.81   14.36   13.94   13.54   13.17   12.81   12.47   12.15   11.85

PERIOD (SEC)     4.10    4.20    4.30    4.40    4.50    4.60    4.70    4.80    4.90    5.00
PSV (IN/SEC)    11.56   11.28   11.02   10.77   10.53   10.30   10.08    9.87    9.67    9.48

PERIOD (SEC)     5.10    5.20    5.30    5.40    5.50    5.60    5.70    5.80    5.90    6.00
PSV (IN/SEC)     9.29    9.11    8.94    8.78    8.62    8.46    8.32    8.17    8.03    7.90

PERIOD (SEC)     6.10    6.20    6.30    6.40    6.50    6.60    6.70    6.80    6.90    7.00
PSV (IN/SEC)     7.77    7.64    7.52    7.41    7.29    7.18    7.07    6.97    6.87    6.77

PERIOD (SEC)     7.10    7.20    7.30    7.40    7.50    7.60    7.70    7.80    7.90    8.00
PSV (IN/SEC)     6.68    6.58    6.49    6.40    6.32    6.24    6.16    6.08    6.00    5.92

PERIOD (SEC)     8.10    8.20    8.30    8.40    8.50    8.60    8.70    8.80    8.90    9.00
PSV (IN/SEC)     5.85    5.78    5.71    5.64    5.58    5.51    5.45    5.39    5.33    5.27

PERIOD (SEC)     9.10    9.20    9.30    9.40    9.50    9.60    9.70    9.80    9.90   10.00
PSV (IN/SEC)     5.21    5.15    5.10    5.04    4.99    4.94    4.89    4.84    4.79    4.74
```

```
W I N D   L O A D   A N A L Y S I S

ISITE=     3     ITEST=     2     ITY=     0     ISHAPE=     1

 USERS VALUE OF WIND VELOCITY -FASTEST MILE AT 30 FT ABOVE GROUND - FREE FIELD IN MPH =     100.00




             T O R N A D O   L O A D   A N A L Y S I S

           TORNADO WIND VELOCITY =  200.00  MILES PER HOUR

           LIFE TIME OF BUILDING IN YEARS =   50.00
           ANNUAL NUMBER OF TORNADOS. . . =     .00
           PROBABILITY OF BEING HIT . . . =   0.000
```

STRUCTURAL ANALYSIS

```
NUMBER OF STORIES =     2

TOTAL BUILDING WIDTH (INCHES) =  1050.0

TOTAL BUILDING LENGTH (INCHES) =  1780.0

HEIGHT OF PARAPET (INCHES)     =   45.0


NUMBER OF FRAMES  =     9


*** FRAME NO.  1 ***   FRAME MODELING OPTION =    2



 NUMBER OF BAYS  =    5

 BEAMS     E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

 COLUMNS   E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00


BEAM TYPE          AB         IB         FB

       1       720.0  121500.0       1.20

COLUMN TYPE        AC         IC         FC

       1       860.0  530046.7       1.20
       2       600.0  180000.0       1.20
       3       201.1    3217.0       1.11

BAY WIDTHS ------

    1 BAYS AT   122.000 INCHES
    1 BAYS AT   109.000 INCHES
    1 BAYS AT   440.000 INCHES
    1 BAYS AT   109.000 INCHES
    1 BAYS AT   122.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT   168.000 INCHES

*** FRAME NO.  2 ***   FRAME MODELING OPTION =    2



 NUMBER OF BAYS  =    5

 BEAMS     E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00
 COLUMNS    E=    3000.0   G=    1300.0   W(LBS/CU.FT)=    150.00

BEAM TYPE           AB         IB          FB

        1         720.0    121500.0        1.20

COLUMN TYPE         AC         IC          FC

        1         860.0    530046.7        1.20
        2         600.0    180000.0        1.20
        3         201.1      3217.0        1.11

BAY WIDTHS ------

    1 BAYS AT    122.000 INCHES
    1 BAYS AT    109.000 INCHES
    1 BAYS AT    440.000 INCHES
    1 BAYS AT    109.000 INCHES
    1 BAYS AT    122.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT    168.000 INCHES

*** FRAME NO.  3 ***    FRAME MODELING OPTION =     2


 NUMBER OF BAYS  =     3

 BEAMS      E=    3000.0   G=    1300.0   W(LBS/CU.FT)=    150.00

 COLUMNS    E=    3000.0   G=    1300.0   W(LBS/CU.FT)=    150.00

BEAM TYPE           AB         IB          FB

        1         300.0      8814.2        2.16

COLUMN TYPE         AC         IC          FC

        1         201.1      3217.0        1.11
        2         324.0      8748.0        1.20
        3         400.0     13333.3        1.20

BAY WIDTHS ------

    1 BAYS AT    296.000 INCHES
    1 BAYS AT    440.000 INCHES
    1 BAYS AT    296.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT    168.000 INCHES

*** FRAME NO.  4 ***    FRAME MODELING OPTION =     2
```

```
 NUMBER OF BAYS  =    3

 BEAMS      E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

 COLUMNS    E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

BEAM TYPE          AB        IB         FB

       1       300.0     8814.2       2.16

COLUMN TYPE        AC        IC         FC

       1       201.1     3217.0       1.11
       2       324.0     8748.0       1.20
       3       400.0    13333.3       1.20

BAY WIDTHS ------

    1 BAYS AT   296.000 INCHES
    1 BAYS AT   440.000 INCHES
    1 BAYS AT   296.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT    168.000 INCHES

*** FRAME NO.  5 ***   FRAME MODELING OPTION =    2


 NUMBER OF BAYS  =    3

 BEAMS      E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

 COLUMNS    E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

BEAM TYPE          AB        IB         FB

       1       300.0     8814.2       2.16

COLUMN TYPE        AC        IC         FC

       1       201.1     3217.0       1.11
       2       324.0     8748.0       1.20
       3       400.0    13333.3       1.20

BAY WIDTHS ------

    1 BAYS AT   296.000 INCHES
    1 BAYS AT   440.000 INCHES
    1 BAYS AT   296.000 INCHES

STORY HEIGHTS -------
```

```
    2 STORIES AT   168.000 INCHES

*** FRAME NO.  6 ***   FRAME MODELING OPTION =    2


  NUMBER OF BAYS  =    3

  BEAMS      E=   3000.0  G=    1300.0  W(LBS/CU.FT)=   150.00

  COLUMNS    E=   3000.0  G=    1300.0  W(LBS/CU.FT)=   150.00

BEAM TYPE          AB         IB         FB

        1         300.0     8814.2       2.16

COLUMN TYPE        AC         IC         FC

        1         201.1     3217.0       1.11
        2         324.0     8748.0       1.20
        3         400.0    13333.3       1.20

BAY WIDTHS ------

    1 BAYS AT   296.000 INCHES
    1 BAYS AT   440.000 INCHES
    1 BAYS AT   296.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT   168.000 INCHES

*** FRAME NO.  7 ***   FRAME MODELING OPTION =    2


  NUMBER OF BAYS  =    4

  BEAMS      E=   3000.0  G=    1300.0  W(LBS/CU.FT)=   150.00

  COLUMNS    E=   3000.0  G=    1300.0  W(LBS/CU.FT)=   150.00

BEAM TYPE          AB         IB         FB

        1         420.0    14014.5       1.51
        2         394.0    12473.8       1.12
        3         492.0    16516.4       1.36

COLUMN TYPE        AC         IC         FC

        1         348.0     7424.0       1.20
        2         324.0     8748.0       1.20
        3         256.0     5461.3       1.20
        4         201.1     3217.0       1.11
        5         400.0    13333.3       1.20
```

```
BAY WIDTHS ------

    1 BAYS AT   296.000 INCHES
    2 BAYS AT   220.000 INCHES
    1 BAYS AT   296.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT   168.000 INCHES

*** FRAME NO.  8 ***   FRAME MODELING OPTION =    2


 NUMBER OF BAYS  =    4

 BEAMS      E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

 COLUMNS    E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

BEAM TYPE          AB         IB          FB

        1        420.0     14014.5       1.51
        2        394.0     12473.8       1.12
        3        492.0     16516.4       1.36

COLUMN TYPE        AC         IC          FC

        1        348.0      7424.0       1.20
        2        324.0      8748.0       1.20
        3        256.0      5461.3       1.20
        4        201.1      3217.0       1.11
        5        400.0     13333.3       1.20

BAY WIDTHS ------

    1 BAYS AT   296.000 INCHES
    2 BAYS AT   220.000 INCHES
    1 BAYS AT   296.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT   168.000 INCHES

*** FRAME NO.  9 ***   FRAME MODELING OPTION =    2


 NUMBER OF BAYS  =    4

 BEAMS      E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

 COLUMNS    E=   3000.0  G=   1300.0  W(LBS/CU.FT)=   150.00

BEAM TYPE          AB         IB          FB
```

```
            1       420.0    14014.5        1.51
            2       402.0    12679.5        1.11

COLUMN TYPE           AC          IC          FC

            1       201.1     3217.0        1.11
            2       324.0     8748.0        1.20
            3       256.0     5461.3        1.20
            4       495.0    16500.0        1.20
            5       400.0    13333.3        1.20
            6       522.0    14094.0        1.20

BAY WIDTHS ------

    1 BAYS AT   296.000 INCHES
    2 BAYS AT   220.000 INCHES
    1 BAYS AT   296.000 INCHES

STORY HEIGHTS -------

    2 STORIES AT   168.000 INCHES



STIFFNESS MATRIX (K1PS/IN)



  6.03+03  -9.33+03
 -9.33+03   2.55+04

TOTAL WEIGHT VECTOR (KIPS)


   1.84+03
   2.34+03
```

```
CHARACTERISTIC VECTORS


    1.00+00  -5.21-01
    4.11-01   1.00+00




                    E A R T H Q U A K E   R E S P O N S E   A N A L Y S I S


DAMPING CURVE OPTION =    1

MAXIMUM NUMBER ITERATIONS =    6

MODIFY RESPONSE FOR DUCTILITY =    1

MODAL COMBINATION OPTION =    2

EFFECTIVE INTERSTORY DRIFT TO YIELD BY STORY (IN/IN)

   6.00-03   6.00-03

CRITICAL DAMPING (PERCENT) =    6.62
```

```
MODE  FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL    MAXIMUM  AMPLITUDE     PS.SPECT.VEL. MODIFIED FOR DUCTILITY
 NO.    (CPS)   (SEC.)  RATIO    VELOCITY     BASE SHEAR   RATIO      (ACCEL)      (DISPL)

  1     3.4126   .293   .840      12.036      2346.225       .793      12.036       12.036

  2    10.0000   .100   .160       2.362       256.670      2.061       2.362        2.362
STORY             I. S. DEFL         VELOCITY            ACCELERATION
 NO.                (IN)            (IN/SEC)                 (G)

  1               4.4204-01         1.5676+01            9.3388-01
  2               3.0720-01         7.3419+00            5.3021-01
DUCTILITY BY STORY

   4.39-01   3.05-01

EFFECTIVE DUCTILITY FOR BUILDING =     .35

CRITICAL DAMPING (PERCENT) =     3.87



MODE  FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL    MAXIMUM  AMPLITUDE     PS.SPECT.VEL. MODIFIED FOR DUCTILITY
 NO.    (CPS)   (SEC.)  RATIO    VELOCITY     BASE SHEAR   RATIO      (ACCEL)      (DISPL)
  1     3.4125   .293   .840      13.058      2545.280       .798      13.058       13.058
  2     9.9997   .100   .160       2.362       256.670      2.061       2.362        2.362
STORY             I. S. DEFL         VELOCITY            ACCELERATION
 NO.                (IN)            (IN/SEC)                 (G)

  1               4.7721-01         1.6956+01            1.0049+00
  2               3.3174-01         7.8678+00            5.5938-01
DUCTILITY BY STORY

   4.73-01   3.29-01

EFFECTIVE DUCTILITY FOR BUILDING =     .37

CRITICAL DAMPING (PERCENT) =     4.00
```

```
MODE  FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL   MAXIMUM  AMPLITUDE     PS.SPECT.VEL. MODIFIED FOR DUCTILITY
 NO.    (CPS)   (SEC.)  RATIO   VELOCITY     BASE SHEAR   RATIO      (ACCEL)      (DISPL)

 1      3.4124   .293   .840     12.996      2533.137       .798     12.996      12.996
 2      9.9994   .100   .160      2.362       256.670      2.061      2.362       2.362

STORY          I. S. DEFL             VELOCITY              ACCELERATION
 NO.             (IN)                 (IN/SEC)                  (G)

 1             4.7510-01              1.6878+01             1.0005+00
 2             3.3026-01              7.8360+00             5.5760-01

DUCTILITY BY STORY

   4.71-01   3.28-01

EFFECTIVE DUCTILITY FOR BUILDING =    .37

CRITICAL DAMPING (PERCENT) =    3.99



                    W I N D   R E S P O N S E   A N A L Y S I S



             BUILDING SHAPE CODE =    24     WIND DIRECTION CODE =     1



           EXTERNAL PRESSURE COEFFICIENT FOR WALL 1 . . .=    .800
           EXTERNAL PRESSURE COEFFICIENT FOR WALL 2 . . .=   -.600
           SHAPE FACTOR FOR WIND DIRECTION . . .=   1.400

           WIND DIRECTION WITH RESPECT TO
           NORMAL OF WALL 1 . . . . . . . . . . . . . =    .0 DEGGREES


            OPEN AREA RATIO =     .360     WALL CODE =     5
```

```
WIND ANALYSIS

STORY  DEFLECTION  DRIFT    STORY SHEAR
 NO.    (INCHES)  (IN/IN)     (KIPS)

  1        .014     .0000      23.09
  2        .007     .0000      59.94
```

```
          L O N G   S P A N   R O O F   A N A L Y S I S


        ANALYSIS CODE . . . . .=     2
        SLOPE OF ROOF . . . . .=      .00 DEGREES
        ROOF UPLIFT CAPACITY   =   3.400+06 POUNDS
        COLLAPSE CAPACITY . . .=   3.000+07 POUNDS
        DEPTH OF PONDING  . . .=      .00 FEET
        ROOF UPLIFT LOAD. . . .=  -5.574+05 POUNDS
        PONDING LOAD. . . . . .=   0.000    POUNDS
```

```
                    D A M A G E   A N A L Y S I S

DRIFT TO YIELD BY STORY (FRAME)

   6.00-03   6.00-03

COEFFICIENT OF VARIATION BY STORY

   1.50-01   1.50-01

DRIFT TO YIELD BY STORY (WALL)

   6.00-03   6.00-03

COEFFICIENT OF VARIATION BY STORY

   1.50-01   1.50-01

DRIFT TO YIELD BY STORY (DIAPHRAGM)

   6.00-03   6.00-03

COEFFICIENT OF VARIATION BY STORY

   1.50-01   1.50-01

HEIGHT OF WINDOWS BY STORY (INCHES)

   4.80+01   4.80+01

WIDTH OF WINDOWS BY STORY (INCHES)

   5.30+01   5.30+01

DUCTILITY TO FAILURE BY STORY (FRAME)

   7.00+00   7.00+00

COEFFICIENT OF VARIATION BY STORY

   1.50-01   1.50-01
```

```
DUCTILITY TO FAILURE BY STORY (WALL)

   7.00+00   7.00+00

COEFFICIENT OF VARIATION BY STORY

   1.50-01   1.50-01

DUCTILITY TO FAILURE BY STORY (DIAPHRAGM)

   7.00+00   7.00+00

COEFFICIENT OF VARIATION BY STORY

   1.50-01   1.50-01

QUALITY FACTOR OF CONSTRUCTION BY STORY

   2.00+00   2.00+00

AVERAGE CLEARANCE IN MULLIONS (INCHES)

   1.25-01   1.25-01

COEFFICIENT OF VARIATION BY STORY

   5.00-02   5.00-02

DRIFT TO YIELD BY STORY (PARTITIONS)

   4.00-03   4.00-03

COEFFICIENT OF VARIATION BY STORY

   5.00-02   5.00-02

THICKNESS OF WINDOW GLASS BY STORY (INCHES)

   1.25-01   1.25-01

MEAN BREAKING STRESS OF GLASS

   2.00+04

COEFFICIENT OF VARIATION BY STORY

   5.00-02   5.00-02
```

```
STRUCTURAL DAMAGE DUE TO EARTHQUAKE (PERCENT)

STORY              FRAME          WALL           DIAPHRAGM
 NO.               DAMAGE         DAMAGE         DAMAGE


  1                   .02            .02            .02
  2                   .00            .00            .00
NONSTRUCTURAL DAMAGE DUE TO EARTHQUAKE (PERCENT)

STORY   MMI        MMI       MMI        MULLION   NONSTR    GLASS
 NO.    (A)        (V)       (A.V)       DRIFT    DAMAGE    DAMAGE


  1    10.3        8.5       10.3       2.83-03   100.00       .00
  2     9.4        7.6        9.4       1.97-03    26.82       .00




STRUCTURAL DAMAGE DUE TO WIND (PERCENT)

STORY              FRAME          WALL           DIAPHRAGM
 NO.               DAMAGE         DAMAGE         DAMAGE


  1                   .00            .00            .00
  2                   .00            .00            .00
```

```
NONSTRUCTURAL DAMAGE DUE TO WIND (PERCENT)

STORY             PARTITIONS    GLASS DAMAGE DUE TO DIRECT PRESSURE
 NO.              DAMAGE        WALL 1       WALL 2       WALL 3       WALL 4       CORNERS

   1                 .00           .00          .00          .00          .00         86.42
   2                 .00           .00          .00          .00          .00          2.73
DAMAGE TO LONG-SPAN ROOF

         TIE-DOWN CAPACITY AND DEAD WEIGHT CAPACITY ARE
         ADEQUATE TO RESIST PREDICTED LEVELS OF NET UPLIFT
         DUE TO WIND, AND COLLAPSE DUE TO PONDING (IF ANY).
         NO DAMAGE IS PREDICTED.


                 W I N D   R E S P O N S E   A N A L Y S I S


                 W I N D   D U E   T O   T O R N A D O



WIND ANALYSIS

STORY  DEFLECTION  DRIFT    STORY SHEAR
 NO.   (INCHES)   (IN/IN)     (KIPS)

  1        .047    .0001      75.26
  2        .022    .0001     206.98
```

```
                         L O N G   S P A N   R O O F   A N A L Y S I S


                    ANALYSIS CODE . . . . .=     2
                    SLOPE OF ROOF . . . . .=      .00 DEGREES
                    ROOF UPLIFT CAPACITY   =   3.400+06 POUNDS
                    COLLAPSE CAPACITY . . .=   3.000+07 POUNDS
                    DEPTH OF PONDING  . . .=      .00 FEET
                    ROOF UPLIFT LOAD. . . .=  -1.329+06 POUNDS
                    PONDING LOAD. . . . . .=   0.000    POUNDS




                              D A M A G E   A N A L Y S I S




          STRUCTURAL DAMAGE DUE TO WIND (PERCENT)

          STORY              FRAME           WALL            DIAPHRAGM
           NO.               DAMAGE          DAMAGE          DAMAGE

            1                  .00             .00             .00
            2                  .00             .00             .00
```

```
NONSTRUCTURAL DAMAGE DUE TO WIND (PERCENT)

STORY          PARTITIONS   GLASS DAMAGE DUE TO DIRECT PRESSURE
 NO.           DAMAGE       WALL 1      WALL 2      WALL 3      WALL 4      CORNERS


  1               .00       100.00      100.00      100.00      100.00      100.00
  2               .00       100.00      100.00      100.00      100.00      100.00

DAMAGE TO LONG-SPAN ROOF

      TIE-DOWN CAPACITY AND DEAD WEIGHT CAPACITY ARE
      ADEQUATE TO RESIST PREDICTED LEVELS OF NET UPLIFT
      DUE TO WIND, AND COLLAPSE DUE TO PONDING (IF ANY).
      NO DAMAGE IS PREDICTED.

END OF JOB.


@FIN
```

4.6 SUMMARY

Table 4.1 presents a general summary of the damage evaluation obtained using each of the three methods noted in chapter 3. Earthquake, wind and tornado loadings were considered. While each method presents the evaluation in a somewhat different format it is clear from table 4.1 that the general evaluation of the building is consistent.

It is not the intent of this demonstration example to compare the relative merits of the three methods. This example problem demonstrates the benefits of performing a building evaluation using all of the methods. Such an approach provides the engineer with a total insight into the problem which would not be possible if only one method were used.

Table 4.1 Summary of Evaluation for Demonstration Building

Natural Hazard	Field Evaluation Method	Approximate Analytical Method	Detailed Analytical Method
Earthquake (MMI 9.5)	Poor Structural Rating Fair Nonstructural Rating	Very Poor Structural Rating Poor Nonstructural Rating	2% Structural Damage 63% Non structural Damage
Wind (100 mph)	Fair Structural Rating Fair to Good Non-Structural Rating	Good Structural Rating No Interior Non-Structural Damage	0% Structural Damage 44% Corner Window Damage
Tornado (200 mph)	Fair Structural Rating Good Rating for Walls Poor Rating for Windows	Good Structural Rating Noted Potential for Missile Damage	0% Structural 100% Window Damage

At the present time there exists very few full scale structures which have been severely damaged during the occurrence of a natural hazard and have recorded building response or wind velocity data. Insight into the area of damage evaluation can only be improved as more such quantitative data are obtained. Therefore, the user must recognize not only the inherent uncertainty in his selection of values of input parameters for each of the damage evaluation methods presented, but also the uncertainty in what seismic and wind excitation levels cause damage to different classes of buildings. To be sure, this area requires considerable research. By the working of examples of the type presented in this chapter, however, the user will gain an appreciation for what the key parameters are and what general levels of damage he can expect for a particular building. Learning of this type is a significant and essential step toward safe design.

5. SUMMARY

This report presents a methodology for evaluating the potential damage of buildings due to earthquake and extreme wind including tornado and hurricane. Three independent, but related, sets of procedures are developed. These ranged from a qualitative procedure based on field survey data to a detailed analytical procedure involving a digital computer program. Historical seismic and meteorological data are used as the basis for establishing environmental loads. Damage estimates are based on empirical correlations between structural response and observed damage coupled with engineering judgment.

The methodology presented in this report incorporated the state-of-the-practice techniques available in the engineering profession. However, it is recognized that because of the increased social and political interest in disaster mitigation in recent years, this entire area of research is in a stage of rapid development. Therefore, it is anticipated that the methodology will be periodically up-dated.

Based on experience gained in the development of this methodology, it is recommended that consideration be given to further study of the following topics to improve its further application:

1. Sensitivity Study

The present methodology incorporates many parameters from many diverse areas of engineering. Some parameters have a direct effect upon the final answer whereas the influence of other parameters is indirect and difficult to visualize. Therefore, an analytically based sensitivity study using perturbation theory concepts should be undertaken. The alternative to such a systematic sensitivity study is a parametric study involving many hundreds of problem solutions; this is inefficient and undesirable.

2. Damage Data

More structural and nonstructural damage data from future disasters will contribute greatly to the refinement of the present methodology. It is highly desirable that the data be recorded in a format which is compatible with the methodology. Thus, the data should be obtained in a systematic manner with the mechanics of the data gathering established prior to the occurrence of the natural disaster.

3. Program Module Modification

The building modeling techniques should be extended to include torsional motions. Recent full scale test data indicate that this response mode is important in both wind and earthquake excitation, and because it seems to most significantly effect floor accelerations away from the building's center of mass, it should have a significant influence upon nonstructural damage estimates. While modeling techniques for three-dimensional tier buildings are available, certain problems associated with the inclusion of a torsional modeling capability exist. They are, (i) the specification of torsional modal damping values, (ii) evaluating the distribution of damage to floors, i.e., to corners, center, etc., and (iii) generation of earthquake ground motion spectra and wind loads which reflect the characteristics of observed loading in the two perpendicular translational building motion directions.

The inclusion of a module for analyzing a building for its earthquake inelastic time dependent response should be considered. Presently, the user has the option of modifying the site spectra for ductility. The modification factors are meant to provide intelligent estimates of inelastic response without a detailed inelastic response analysis. It is recognized that such estimates are approximate. Significant problems exist in incorporating an inelastic response procedure. Among these problems are, (i) the need to generate ground displacement time histories for a site, and (ii) the characterization of acceptable analytical strain-displacement relationships (e.g., elastic-plastic, stiffness - degrading, etc.) for each of the building types noted in this report.

Finally, the quantification of uncertainties introduced at various stages of the analysis, and a systematic treatment of their combined influence on damage estimates is essential. Such an effort would not only result in a quantitative assessment of uncertainty in the damage estimates, but would point out the sensitivity of the final results to specific sources of error. A separate subprogram module could be developed to operate on the uncertainties associated with each stage of computation.

This report represents a first step in the area of damage evaluation. It should and will be modified and improved with time and experience. The modular form of the computer program was purposely designed for this reason. The importance of this report can best be appreciated by recognizing that it brings together a detailed modeling of the many areas of natural hazard damage evaluation by utilizing a systems engineering approach.

6. REFERENCES

[1.1] Wiggins, J. H., Jr., and Moran, D. F., Earthquake Safety in the City of Long Beach Based on the Concept of Balanced Risk, J. H. Wiggins Company, Redondo Beach, California (September 1971).

[1.2] Earthquake Resistance Design Requirements for VA Hospital Facilities, Handbook H-08-8, Office of Construction, Veterans Administration, Washington, D.C. (June 1973).

[1.3] Phase III and Phase IV Seismic Study of Puget Sound Naval Shipyard, Bremerton, Washington, Prepared for Western Division Naval Facilities Engineering Command, San Bruno, California by John A. Blume and Associates (May 1973).

[1.4] National Bureau of Standards (U.S.), Building Science Series 46, (February 1973).

[2.1] Gutenberg, B. and Richter, C. F., "Seismicity of the Earth and Associated Phenomena," Princeton University Press, Princeton, N. J., (1954).

[2.2] Benioff, H. and Gutenberg, B., "General Introduction to Seismology," Earthquakes in Kern County During 1952, State of California, Division of Mines, Bulletin 171, San Francisco, (1955).

[2.3] Richter, C.F., Elementary Seismology, W. H. Freeman and Co., San Francisco, (1958).

[2.4] U.S. Department of Defense, "The Effects of Nuclear Weapons," S. Glasstone, Editor; Government Printing Office, Washington, D.C. (1962).

[2.5] "Uniform Building Code," 1973 Edition, published by International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601.

[2.6] Greensfelder, R., "Maximum Expected Bedrock Acceleration from Earthquakes in California," Unpublished California Division of Mines and Geology Map, (1972).

[2.7] Davenport, A.G.and Milne, W. G., "Earthquake Probability," Proceedings of the Fourth World Conference on Earthquake Engineering, Santiago, Chile, (1968).

[2.8] Whitman, R.V., Roesset, J.M., Dobry, R. and Ayestaran, L., "Accuracy of Modal Superposition for One-Dimensional Soil Amplification Analysis," Proc. of International Conference or Microzonation, Seattle, Washington, October, 1973.

[2.9] Hart, G.C., DiJulio, R.M. and M. Lew, "Torsional Response and Design of High-Rise Buildings," Proc. Paper No. 2266, ASCE National Structural Engineering Meeting, April, 1974.

[2.10] Berg, G.V., and Degenkolb, H.J., "Engineering Lessons From the Managua Earthquake," Earthquake Engineering Research Institute Conference Proceedings--Managua, Nicaragua Earthquake of December 23, 1972, Vol. II, November 29 and 30, 1973, San Francisco, California, 1973.

[2.11] Hanson, R.D., and Degenkolb, H.J., "The Venezuela Earthquake--July 29, 1967," American Iron and Steel Institute, New York, New York, 1969.

[2.12] McKaig, T.H., "Building Failures--Case Studies in Construction and Design," McGraw-Hill Book Co., New York, New York, 1962.

[2.13] Mehta, K.C., et al, "Response of Structural Systems to the Lubbock Storm," T T U SRR 03, Texas Tech University, 1971.

[2.14] Dikkers, R.D., Marshall, R.D., and Thom, H.C.S., "Hurricane Camille -- August 1967," Technical Note 569, National Bureau of Standards, Washington, D. C., 1971.

[2.15] Somes, N.F., Dikkers, R.D., and Boone, T.H., "Lubbock Tornado-A Survey of Building Damage in An Urban Area," Technical Note 558, National Bureau of Standards, Washington, D. C., 1971.

[2.16] Koppes, W.F., "Design Wind Loads for Building Wall Elements," Building Science Series 30, National Bureau of Standards, Washington, D. C. 1970.

[3.1] "Seismic Design for Buildings," by Departments of the Army, the Navy and the Air Force, (April 1973). (Army TM 5-809-10; Navy FAC P-355; Air Force AFM 88-3, Chapter 13).

[3.2] "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures" (ANSI A58.1-1972), American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

[3.3] Mehta, Kishor C., Minor, Joseph E., and McDonald, James R., "Tornadoes and Extreme Winds Research Program," ASCE Annual and National Environmental Engineering Meeting, Houston, Texas. Meeting Preprint 1797, (October 1972).

[3.4] Dunlap, James A., and Weidner, Karl, "Nuclear Power Plant Tornado Design Considerations," Journal of the Power Division, Proceedings of the American Society of Civil Engineers, (March 1971).

[3.5] Newmark, N.M., and Rosenblueth, E., "Fundamentals of Earthquake Engineering," Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1971.

[3.6] "Recommended Lateral Force Requirements and Commentary," by Seismology Committee of the Structural Engineers Association of California, 1973 (173 Second Street, San Francisco, California 94105).

[3.7] Gaylord, E.H. and Gaylord, C. N., Structural Engineering Handbook, McGraw-Hill Book Company (1968).

[3.8] Grinter, L.,"Theory of Modern Steel Structures, Volume II," MacMillian Company, 1942.

[3.9] Wilson, E.L., and Dovey, H. H., "Three-Dimensional Analysis of Building Systems - TABS," Report No. EERC 72-8, Earthquake Engineering Research Center, College of Engineering, University of California, Berkeley, California, (December 1972). (For sale by the National Technical Information Service, National Bureau of Standards, U.S. Department of Commerce, Springfield, Virginia 22151)

[3.10] "Research Recommendations" of International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601.

[3.11] Wiggins, J. H., Hart, G. C., Hasselman, T.K. and White, R. W., "Methodology for Hazard Risk Evaluation of Buildings," J. H. Wiggins Company Technical Report No. 73-1152, October 1973. (Available from NTIS)

[3.12] *United States Earthquakes, Parts I and II*, U.S. Coast and Geodetic Survey (1966).

[3.13] *World Earthquakes, 1961-1972*, NOAA, published bi-monthly since January 1, 1961.

[3.14] Nuttli, Otto, "On the Recurrence Rate of Lower Mississippi Valley Earthquakes," *Presented at the Seis. Soc. Am. Meeting*, May 16-19, 1973.

[3.15] Bollinger, G.A., "Seismicity of the South Eastern United States," *Presented at the Seis. Soc. Am. Meeting*, (May 16-19, 1973).

[3.16] Chinnery, M.A., "Earthquake Risk in Southern New England," *Presented at the Seis. Soc. Am. Meeting*, (May 16-19, 1973).

[3.17] Gordon, D.W., "An Interpretation of New England Seismicity," *Presented at the Seis. Soc. Am. Meeting*, (May 16-19, 1973).

[3.18] Wiggins, J. H., "Construction of Strong Motion Response Spectra from Magnitude and Distance Data," *Bull. Seis. Soc. Am.* (1964).

[3.19] Gutenberg, B. and Richter, C.,"Earthquake Magnitude, Intensity, Energy, and Acceleration," *Bulletin of the Seismological Society of America*, 46:105-145 (1956).

[3.20] Wiggins, J. H., *The Effect of Soft Surficial Layering on Earthquake Intensity*, Civil Engineering Studies, Structural Research Series No. 216, University of Illinois, (1969).

[3.21] Wiggins, J. H., "Effects of Site Conditions on Earthquake Intensity," *Journal of the Structural Division*, ASCE, (1964)

[3.22] *USGS, Landforms of the United States*, Stock Number 2401-2192, (1972).

[3.23] Nuttli, O., *State of the Art for Assessing Earthquake Hazards in the United States, Report #1, Design Earthquakes for the Central United States*.

[3.24] Barosh, P.J., *Use of Seismic Intensity Data to Predict the Effects of Earthquakes and Underground Nuclear Explosions in Various Geologic Settings*, Geological Survey Bulletin 1279, (1969).

[3.25] Orphal, D.L. and Lahoud, J.A., "Prediction of Peak Ground Motion from Earthquakes," *Presented at the Seis. Soc. Am. Meeting*, May 16-19, 1973.

[3.26] Campbell,K.W. and Duke, C.M., "Bedrock Intensity Attenuation and Site Factors from San Fernando Earthquake Records," *Presented at the Seis. Soc. Am. Meeting*, (May 16-19, 1973).

[3.27] Medvedev, S. V., *Engineering Seismology*, Translated from Russian by the U.S. Department of Commerce, (1969).

[3.28] Thom, H.C.S., "Frequency of Maximum Wind Speeds," *Proceedings, ASCE*, Volume 80, (1954).

[3.29] Thom, H.C.S., "Distribution of Extreme Winds in the United States," Journal of the Structural Division, ASCE, (April 1960).

[3.30] Thom, H.C.S., "New Distributions of Extreme Winds in the United States," Journal of the Structural Division, ASCE, (1968).

[3.31] Davenport, A.G., "Rationale for Determining Design Wind Velocities," Journal of the Structural Division, ASCE, (May 1960).

[3.32] Davenport, A.G., "Gust Loading Factor," Journal of the Structural Division, ASCE, (June 1967).

[3.33] Vellozzi, J.W. and Cohen, E., "GUST Response Factors," Journal of the Structural Division, Volume 94, (June 1968).

[3.34] Singell, Thomas W., "Wind Forces on Structures: Forces on Enclosed Structures," Journal of the Structural Division, ASCE, (July 1958).

[3.35] Standards of the Swiss Association of Engineers and Architects on Load Assumptions, Acceptance and Supervision of Buildings, Scheizerischer Ingenieur and Architekten Vasein, Technische Normen No. 160, (1956).

[3.36] McGuire, William, Steel Structures, Prentice-Hall, Englewood Cliffs, New York, Chapter 3.7, (1969).

[3.37] Sherman, Z., "Residential Buildings Engineered to Resist Tornadoes," Journal of the Structural Division, ASCE, (April 1973).

[3.38] Thom, H.C.S., "Tornado Probabilities," Monthly Weather Review, (1963).

[3.39] Mehta, K.C., et al, Response of Structural Systems to the Lubbock Storm, Texas Tech University Storm Research Report 03, Lubbock, Texas, (October 1971).

[3.40] Friedman, D.G., "Perspective View of the Natural Disasters in the United States," Presented at the Systems Safety Society Symposium, (July 18, 1973).

[3.41] Lionberger, Steve R., and William Weaver, Jr., "Dynamic Response of Frames with Non-Rigid Connections," J. Engr. Mech: Div., ASCE, (1969).

[3.42] Weaver, Wm., Jr., and Nelson, M.F., "Three-Dimensional Analysis of Tier Buildings," Journal of the Structural Division, ASCE, (1966).

[3.43] Clough, R.W., King, I.P. and Wilson, E.L., "Structural Analysis of Multistory Buildings," J. Structural Div., ASCE, (1964).

[3.44] Housner, G.W., and Brady, A.G., "Natural Periods of Vibration of Buildings," Journal of Engineering Mech. Div. ASCE, (1963).

[3.45] Husid, R., and Conrad, P., "Fundamental Period of Framed Structures," Bull. of International Institute of Seismology and Earthquake Engineering, (1971).

[3.46] Takeuchi, M., "Vibrational Characteristics of Buildings," Proceedings II World Conference on Earthquake Engineering, (1960).

[3.47] Ifrim, M., "Dynamic Analysis of Tall Structures Subject to Earthquake Motion," Proceedings II World Conference on Earthquake Engineering, (1960).

[3.48] Husid, R., and Bustamante, J., "Discussions of Natural Periods of Vibrations of Buildings," J. of Engr. Mech. Div. ASCE, (1964).

[3.49] Rinne, J.E., "Building Code Provisions for a Seismic Design," Proceedings from the EERI Symposium, "Earthquake and Blast," (June 1952).

[3.50] Hart, G.C., M. Lew and R. M. DiJulio, "High Rise Building Response: Damping and Period Nonlinearities," Proceedings of the Sixth World Conference on Earthquake Engineering, Rome, Italy, (1973).

[3.51] Jennings, P.D. (Editor), "Engineering Features of the San Fernando Earthquake," EERI Report No. 71-02, California Institute of Technology, Pasadena, (1971).

[3.52] Newmark, N.M. and Hall, W., "Seismic Design Criteria for Nuclear Reactor Facilities," Proceedings Fourth World Conference on Earthquake Engineering, Santiago, Chile, (1969).

[3.53] California Institute of Tech., Earthquake Engineering Research Report No. EERL 72-80, August, (1972).

[3.54] Newmark, N.M., "Current Trends in the Seismic Analysis and Design of High-Rise Structures," Earthquake Engineering, Chapter 16, Prentice Hall, (1970).

[3.55] Velestos, A.S. and Newmark, N.M., "Effect of Inelastic Behavior on the Response of Simple Systems to Earthquake Motions," Proceedings of the Second World Conference on Earthquake Engineering, (1960).

[3.56] Velestos, A.S. and Newmark, N.M., "Deformation Spectra for Elastic and Elasto-Plastic Systems Subjected to Ground Shock and Earthquake Motions," Proceedings on the Third World Conference on Earthquake Engineering, (1965).

[3.57] Wiggins, J. H., Earthquake Damage Inspection Manual, San Fernando Earthquake, February 9, 1971, Prepared for the Small Business Administration under contract with the National Bureau of Standards, (April 1972).

[3.58] Steinbrugge, K.V., Schader, E.E., and Moran, D.F., "Building Damage in San Fernando Valley," California Division of Mines and Geology, Sacramento, California, (in press).

[3.59] Steinbrugge, K.V., Schader, E.E., Bigglestone, H.C. and Weers, C. A., San Fernando Earthquake, February 9, 1971, Pacific Fire Rating Bureau, San Francisco.

[3.60] Connor, Logcher and Shing-Ching Chan, "Nonlinear Analysis of Elastic Framed Structures," J. of St. Div. ASCE (June 1968).

[3.61] Wiegel, R.L., Earthquake Engineering, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1970.

[3.62] Fiorato, A. E., Sozen, M. A. Gamble W. A., "An Investigation of the Interaction of Reinforced Concrete Frames With Masonry Filler Walls", University of Illinois Report, Urbana, Illinois, November, 1970.

[3.63] Chinn, James, "Failure of Simply Supported Flat Roofs by Ponding of Rain," Engineering Journal, American Institute of Steel Construction, Vol 2, No 2 April 1965, New York.

[C.1] "Building Code Requirements for Reinforced Concrete (ACI 318-71)," American Concrete Institute, Detroit, Michigan, (1971).

[C.2] "Manual of Steel Construction," American Institute of Steel Construction, New York, N.Y. (1969)

[C.3] "Specification for the Design of Cold-Formed Steel Structural Members," 1968 Ed. American Iron and Steel Institute, New York, N.Y. (1968)

[C.4] "Specifications for Structures of Aluminum Alloys," *Aluminum Construction Manual*, The Aluminum Association, New York, N.Y., (1967)

[D.1] Moran, D.F. and C. Rojahn, EERI/NOAA Report on the *San Fernando Earthquake*, National Oceanic and Atmospheric Administration (to be published February 1974).

[D.2] Hart, G. C. and G. Stillman, "Owner and Occupant Financial Loss to Two Modern High-Rise Buildings During the 1971 San Fernando Earthquake," *UCLA Technical Report No. UCLA-ENGR-7217*. (1972)

[D.3] Hart, G. C., Lew, M. and G. Stillman, "Ambient, Aftershock and Main-shock Response of Two High-Rise Buildings," *Proceedings of the International Conference on Microzonation*, Seattle, Washington. (November 1971)

[D.4] Lew, H.S., et al., "Engineering Aspects of the 1971 San Fernando Earthquake," *Building Science Series 40*, U.S. Department of Commerce, National Bureau of Standards, Washington, D.C. (1971)

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APPENDIX A

DATA COLLECTION FORM

A.1 COMMENTARY ON THE USE OF DATA COLLECTION (DC) FORM

Purpose

Data Collection Form (DC-1 through DC-12) are provided for the Field Data Collection Teams. Comments on the use of this form and suggested methods of procedure are presented herein along with suggestions for equipment to be used by the team. While the data contained on these forms is not necessary for the use of the Detailed Analytical Evaluation Method it does provide significant engineering insight into the building and therefore should in general be collected.

Data Collection Teams should consist of a Team Leader who is familiar with construction and has been briefed on, or is familiar with, lateral force design principles. Other Team members hopefully will be somewhat familiar with construction methods and construction materials. In reporting on stability of equipment it is advantageous to have team members who have some experience in the mechanical and electrical fields so that equipment may be properly identified.

It is intended that the DC Form be used to obtain data for evaluation of earthquake, wind, and tornado hazard. Forms will be supplied to the team with spaces for noting the items expected to be pertinent. Only those building features which are visible are expected to be noted. It is not anticipated that this team will cut into the structure or ceilings to uncover conditions. No form can be expected to cover every conceivable building feature. Thus, notes should be made of unusual conditions not covered by the form.

Entry of buildings for the data collection should be arranged with the Building Owner or Manager and a schedule set up. Some buildings may take more or less time than anticipated, so some adjustments in schedule will probably be necessary. Experience in making the survey and filling out the forms will develop increased accuracy in scheduling. The Owner or Building Manager may know something of the history of the building, such as dates of construction or alterations. The local building code in effect at the time of design may be approximated from the date of construction. Tax records can also be searched for the date but this would usually be done by other than the Data Collection Team members.

When contact is made with the Building Owner or Manager, inquiries should be made as to availability of plans, calculations, and soil or geologic reports. Sometimes these may be available at the site. If not, it is possible that the local Building Department may have plans on file. If plans are not available elsewhere, the name of the architect, engineer, or general contractor should be ascertained. It is possible that plans can be made available through these sources. In some cases plans may not agree with "as built" construction. Change orders, additions and other alterations may have occurred. Field data are therefore essential for verification, even if plans are available.

Field Equipment

A sketch board or clipboard of suitable size for the DC Form should be available. Binoculars will be valuable for checking exterior walls of the taller buildings. A camera should be taken along for taking pictures of exterior walls and items of special interest. Each member of the team should have a small steel tape for measuring wall thicknesses, etc, and a flashlight. However, most building dimensions may be paced off or otherwise estimated. A plumb bob or a carpenter's level is useful in determining the amount of tilt in low rise buildings if some tilt is visible to the eye. A tape recorder will frequently be of considerable value in describing certain conditions for later reference.

Data Collection

The current use of the building should be noted, such as "warehouse," "industrial building," "office building," "retail store," "theater," "church," "apartment house," etc. The presence and location of any large assembly areas should be noted for the file and possible life risk evaluation.

The DC Form calls for sketches of the overall plan and elevations of exterior and interior shear walls, if any. They also call for sketching in the location of shear walls in plan. This may vary from story to story. Additional blank sheets may be required. In sketching the exterior walls, any setbacks should be noted and the presence of veneer, architectural appendages and ornamentation commented on. It should be noted if exterior walls are plastered on the outside.

Exterior Wall Characteristics

The DC Form provides space for describing the exterior walls. Whether the walls are bearing walls, non-bearing walls, curtain walls, or filler walls should be noted as well as the material of the wall and their thicknesses. In a multi-story building with masonry or concrete bearing walls, variations in the thickness of walls with the story height should be noted. Veneer and architectural appendages should be itemized.

The mortar in masonry walls may be roughly checked by digging into the joints with a knife. In some cases, it is possible that the exterior surface of the joints has been pointed up with hard cement mortar, but the rest of the joints may be soft lime mortar. Thus it may be desirable to dig into interior joints.

Data for the evaluation of the lateral force resistance of these walls is the desired. For this reason, all openings should be sketched in walls that could act as shear walls.

Shear Walls

For the purpose of this data collection, a shear wall should be defined. In any building, any masonry or concrete walls not isolated from the frame of the building will attempt to resist lateral deformations between floors and will be considered to be shear walls. If the walls are isolated so that the building may deflect parallel to the plane of the walls without requiring the walls to deflect with the building, the walls are not considered to be shear walls. Usually this isolation requires a separation on three sides with confinement at top or at sides in a direction normal to the wall. Such isolation is expected to be a rare occurrence. In light frame structures or structures without concrete floors or roofs and without masonry or concrete walls, shear walls may be composed of wood studs with wood sheathing or plaster or they may be composed of metal studs and plaster. It is emphasized that curtain or filler walls of concrete or masonry will resist lateral force shears unless isolated.

Interior Shear Walls

The comments made above relating to exterior walls apply also to interior shear walls except that there will probably be no veneer or architectural appendages. All of the openings in these walls may be difficult to determine, particularly in ceiling spaces. An effort should be made at least to scan visible ceiling spaces to determine location of holes in the walls for items such as ductwork. The location of these holes with respect to door openings below the ceiling is important information in the evaluation of these walls.

Reinforced Concrete or Masonry Walls

It is usually not possible to determine the size and spacing of reinforcing steel in these walls by field inspection. There are electronic and magnetic devices that can assist in this but it is not contemplated that such devices be used nor that any extensive cutting be done in the process of collection of data on the DC Form. The thickness of wall, the age of the wall, or the laying of units may be clues in determining whether a unit masonry wall is or is not reinforced.

Common or Party Walls

Some adjacent buildings may have one common wall which, usually, is legally described in a party wall agreement. The presence of party walls should be determined, even though there may be separate ownership, because both buildings must act together in resisting lateral forces.

Parapet Walls

Parapet walls, if not properly reinforced or braced, are possible sources of earthquake hazard, particularly when they are adjacent to a public way. Thus the height, thickness, and material of parapets should be noted as well as their location. Any special anchorage of the parapet wall to the roof system should also be noted on the DC Form.

Expansion Joints or Separation Joints

Long buildings are frequently divided by use of expansion joints to limit the effects of concrete shrinkage or creep or temperature change. Also, separation joints are frequently placed in buildings designed for earthquake resistance to insure that each unit will vibrate independently without banging the other. The location of such joints is usually visible as the joints are covered by a sliding plate or a V-shaped sheet metal device. Such joints should be located on the plan sketches and the effective width of joints noted, where this width can be determined in the field.

In structures such as schools, hospitals, shopping centers, etc., there may be covered walkways between buildings. In most cases these covered walkways may be connected to one or both buildings by a sliding joint. This should be looked for and it should be noted whether or not such joints do exist.

Nonstructural Elements

Partitions may be of many types. In large general office areas, partitions may not extend to the ceiling and are frequently moved. Other partitions which are attached to the ceiling or floor above may not be frequently moved or modified. In such cases the partitions should be stayed laterally by the ceiling or floor and the method of attachment is important. This is particularly important in the case of corridor partitions, elevator enclosures, and stairway enclosures. The method of fastening may be difficult to determine in a small ceiling space, but if available this information should be obtained. Access to ceiling spaces may be possible through access scuttles or doors to attic spaces.

Masonry partitions of hollow tile, brick or concrete block are frequently used in buildings, often where little or no attempt has been made to provide earthquake resistance. When unreinforced, such partitions may represent a hazard to life safety when subjected to a major earthquake shock. When anchored to the undersides of a structural floor or roof system they will act as shear walls until they crack up. This can also happen when such partitions are enclosed by vertical structural elements. There is a special hazard when such partitions enclose exit ways, since their collapse would make the exit way unusable.

It may not be feasible to plot the locations of all non-bearing partitions, but the location of masonry partitions enclosing corridors, elevators, and stairs should be noted. For others, sufficient data of a typical nature should be noted.

Some ceilings are applied directly to the underside of floors or roof. Some are suspended to allow space for ducts or other utilities. Some suspended ceilings use T-bars in which acoustical panels are placed loose. The method of hanging suspended ceilings, and bracing by diagonal suspended wires or other means, and the general type should be noted on the forms.

Damage and Deterioration

The presence of severe cracking in walls should be noted. An experienced engineer can determine the probable cause of such damage from the crack pattern. For instance, in wood frame structures, fine vertical cracks at multiples of stud spacing may be found which are caused by plaster shrinkage. These need not be noted. Diagonal cracks on opposite corners of openings are usually caused by differential settlement. Diagonal cracks at all corners may indicate that earthquake, wind, or other vibration was the cause. X-cracks in wall piers are a typical result of earthquake response. All large diagonal cracks and X-cracks in walls should be noted. Usually these can be sketched on the wall elevations.

It is not feasible on the DC Forms to note or plot all cracks in concrete floors. However, usually large cracks in floors should be noted. Cracks in concrete slabs on grade usually need not be noted.

Some industrial operations involve acids or steam which deteriorate concrete or wood. If there is visual evidence of this, it should be noted. Lactic acid in industries utilizing dairy products may be a cause of such damage. Wood trusses and other timber construction exposed to excess moisture or steam can deteriorate rapidly. Exposed wood trusses over an enclosed swimming pool is one example.

There may be locations where loose stone or tile veneer or an ornamental appendage has fallen off. This would indicate the presence of poor or corroded anchorage. If this condition exists over a public way, it could be a hazard to life and should be noted on the elevations.

Exposure

That portion of the DC Form devoted to "Exposure" includes terminology corresponding to ANSI-A58.1-1972 [3.2] for use in entering the ANSI wind tables. Later in the forms there is space to give the rise and span of arched roofs and the shape of gabled roofs. These are to be noted so that the hazards from internal and external wind pressure can be properly evaluated.

A.2 INSTRUCTIONS FOR COMPLETING DATA COLLECTION FORM FOR NATURAL HAZARDS EFFECTS

These letters and numbers for items shown in these instructions are those appearing on the DC Form.

A. GENERAL DATA

1. Facility Number - This is to be provided by Field Supervisor.
2. Building Name - Enter the name of the building, e.g., John Hancock Center, XYZ Elementary School, etc.
3. Address - Enter street address.
4. City - Enter city or county.
5. State - Enter the name of the state.
6. Zip Code - Enter at least the first three digits if all five digits are not known.
7. Year Built - Obtain from Building Manager or Owner, from plans, or from the corner stone or dedication plaque. It can also be obtained from Sanborn maps if they are available. If none of the above are available, estimate the year built. It is important that this item be obtained as accurately as possible.

8. Date of Major Modifications or Additions, if any - Enter date of any major modifications or additions. In cases where additions have been made, report multiple years if similar type of construction and indicate on Item 20 which part of the building corresponds to which year. Use complete separate DC Form if addition is of a different type.

9. Building Code Jurisdiction - Check appropriate square.

10. & 11. Latitude and Longitude - Enter latitude and longitude in degrees, minutes, and seconds to the nearest 30 seconds. Obtain from COE Field Offices or from U.S. Geodetic Survey maps.

12. Building Use - Enter the current use of the building. Enter also the original use of the building if the current use is different. Otherwise, enter "same." For example, a building can be designed as an apartment house and later modified for commercial use by removing partitions, etc. Such changes usually result in changes in the structural characteristics.

13. The basement is defined as the story with no single wall completely above ground. See figure A.1. Correct assessment of the number of stories above and below ground surface is important for determination of structural response. Enter the number of stories below the first floor according to the above definition. See figure A.2.

14. First Story Height - The height of the first story in some cases may be different from the stories above. It can be approximately determined as the distance between the elevation of the first floor and a point located about half way between the top of the first story window and the bottom of the second story window. If building plan is available, it can be obtained from an elevation view (see figure A.3).

15. Average Upper Story Height - If building plan is not available, it can be determined approximately as the distance between either the top or bottom of windows of two successive stories. See figure A.3. Special story heights should be noted.

16. Exterior of First Story - Usually the exterior treatment of the first story of a building is different from the rest of the stories (figures A.3 and A.4). In some instances it may be the same as the ones above the first story as shown in figure A.5.

17. Roof Overhang - Some buildings have roof elements projecting beyond the face of wall below. These may be ornamental cornices or other features such as shown on the upper portion of figure A.10. Note the approximate extent of such overhangs and on which side of the building this occurs.

18. Proximity to Adjacent Building - Indicate approximate distance in feet to adjacent buildings on each side, front, and rear of building surveyed.

19. Availability of Building Plan - The availability of building plans and calculations is important for possible future detailed studies. The source for obtaining these plans should be indicated.

20. Basic Building Plan -

a. The plan of the building layout at the first floor level is to be drawn to scale. Indicate appropriate scale used. Sample sketches are shown in figure A.6.

b. Location of Shear Walls, Load Bearing Partitions, Cores, and Bracing Systems - The primary function of shear walls, shear cores, and bracing systems is to resist lateral forces on the building. Both shear walls and shear cores are found in steel, concrete, and masonry (load bearing) buildings. Usually, timber buildings also have shear walls. Bracing systems, usually X or K bracing, are found in steel structures.

Shear Walls- Shear walls can be located either around the exterior perimeter of the building or in the interior as shown in figures A.6 and A.7. They usually extend from the foundation to the roof of the building. In most cases, shear walls consist of reinforced concrete, brick, or concrete block. Usually their thickness is not less than six inches. Shear walls are frequently symmetrically disposed about the geometric center of the plan. This may not be the case where the plan of a building does not possess symmetry about both axes.

Shear Core- Enclosure walls of elevator shafts or stairwells usually comprise the shear core. As such they usually extend from the building foundation to the roof. The function of the shear core is the same as the shear wall.

Bracing System- Bracing systems are mainly found in steel buildings which do not have shear walls and/or shear cores. Typical bracing system configurations are illustrated in figure A.8. The bracing system is usually found either in the exterior envelope of a building or hidden inside the elevator shaft or stairwell.

c. Location of Main Frame - Accurate location of the main load resisting frames in a building is important in the assessment of building response to lateral loads. The framing plan in both the longitudinal and transverse directions is required.

d. Expansion joints are sometimes provided in extremely long buildings to control the effect of temperature change. Also, they may be provided in buildings designed for earthquake to separate portions of a building having dissimilar vibration characteristics. The effect of expansion joints is to separate the building into separate units. In such cases the structural system of each unit may need to be rated separately.

e. The location of the streets and alleys should be noted on the overall plan with an approximate north arrow. The sides should be labeled "A," "B," "C," "D," etc., for simplifying identification at a later date.

f. Party Wall - The party wall is a wall commonly shared by two adjacent buildings. This type of wall is frequently found in older buildings.

g. Setback - Buildings are sometimes set back from the base story on one or more sides and at various levels. If this occurs, more than one plan will need to be sketched. This may also be shown on the elevations of exterior walls under Item 21.

21. Elevation of Exterior Walls - It is not uncommon to find openings in shear walls for windows and corridors (figures A.9a and A.9c). These openings may weaken the walls, causing them to sustain serious damage as illustrated in figure A.9b. In some cases, total collapse of a building could result from weakened shear walls. Therefore an accurate assessment of openings in the shear walls is one of the important items in the survey. For load-bearing structures, locations of shear walls are not apparent. In this case, all solid walls are to be considered as shear walls. A simple line sketch as shown in figure A.9c is required for each shear wall. The sketch should indicate as close to the true proportion as possible all openings in the walls from the lowermost story of a building to the roof. If the shear walls do not extend continuously from the foundation to the roof, points of termination should be indicated.

a. In sketching the elevations of the exterior walls, we need to note the openings and their approximate size and spacing. Those portions of wall between openings may be potential shear walls. If the pattern of openings is repetitive, all of the openings on a repetitive series need not be shown. The first two and the last two will normally be sufficient.

b. The exterior walls may be faced with a veneer or cladding, or may be concrete or masonry plastered on the outside. This should be noted on the elevations as well as the presence of appendages such as ornamental cornices, balconies, gargoyles, etc.

c. The material of the exterior walls should be noted. They may be concrete, masonry, metal studs and plaster, wood studs and plaster, or all glass. If veneered or plastered, the material of the walls may not be evident from the inside or the outside. In such cases, tapping the wall with a small solid object will help to determine whether the wall is hollow block, solid grouted block, solid concrete or brick, or studs and plaster. Reinforcement in masonry or concrete walls is not discernable from the surface and such information can only be obtained from the plans.

d. Major cracks or other damage should be noted on the elevations. Cracks larger at one end than the other should be noted, since this may be a clue to the cause of the crack. Other damage includes extensive spalling or weather deterioration.

e. If there is evidence of past damage repair, this should be noted.

f. If there is evidence that appendages have fallen off or have been loosened, or other cladding such as veneer or sheet metal facing has been cracked or otherwise damaged, such items should be noted on the elevations.

22. Interior Shear Walls - Shear walls to be either interior or exterior. In Item 21, instructions for sketching elevations of exterior walls have been given. Interior shear walls are usually the permanent walls around stairway and elevator shafts or the corridor walls. They may be composed of reinforced concrete or masonry. In wood frame buildings they may be made of wood studs with wood or plywood sheathing or of metal studs and plaster or wallboard. All masonry or concrete interior walls should be noted whether reinforced or unreinforced.

a. All openings in these walls should be sketched with approximate sizes.

b. As in exterior walls, the presence and location of major cracks should be noted. Whether or not a crack is wider at one end or the other is a clue to the cause of the crack, so this should be noted on the sketch.

c. If there is evidence of past damage repair, this should be noted.

23. Basement Shelter - A basement is a potential storm shelter if properly protected by a heavy concrete first floor slab.

a. Note whether the floor over the basement is concrete or other by checking the appropriate box.

b. If the floor above is concrete, note the approximate thickness. If concrete joists are used, give the depth and spacing of joists. The weight of this slab is important in resisting uplift pressures from high winds or tornadoes.

c. As a potential shelter, it is important to know how many people can be sheltered for a short time period. For this the space available is required. Sometimes a basement is used to house equipment or to store materials. If so, only the remaining space is available. This available space should be estimated in square feet.

d. Some basements may house dangerous equipment or highly flammable materials. Such a condition should be noted, since this could make the basement unsuitable for a storm shelter.

24. Vault-Like Structure - If this building has a length-width ratio, and a height-width ratio of 2 or under, exterior walls of reinforced concrete or reinforced masonry and a poured-in-place reinforced concrete roof, and if the opening in any wall or in the roof do not exceed 15% of the wall or roof area, check the box marked "Yes." If the building does not conform to this, check the box marked "No."

25. Exterior Wall Summary Sheet - From the description of the exterior walls, some estimate can be made of the age of structure and the type of framing. A typical example of the exterior wall treatment which falls in the category of "extensive architectural ornaments" is shown in figure A.10. The different between running and stacked bond masonry construction is illustrated in figure A.11.

The condition of the wall should indicate:

For concrete wall:

- Whether or not reinforcing bars are exposed.
- Spalling of concrete, if any.
- Cracks, if any.

For Masonry wall:

- Condition of masonry unit, i.e., whether or not cracks appear on the surface (see figure A.12).
- Condition of mortar - In order to determine this item, rubbing or scratching (about 1/2") is needed to see whether the mortar crumbles or not.

The thickness of the wall can be determined by measuring the width of the wall at window or door openings.

B. SITE RELATED INFORMATION

1. Exposure - Check one of the six categories which closely approximates the surrounding conditions.

2. Topography - Enter one of the three ground features surrounding the building. Estimate the rise of the slope on the base of 12. For example, one on twelve (i.e., 1:12) etc.

3. Geologic Formation - The field supervisor should check as to availability of information on the site geology. This can usually be obtained from governmental sources. Geological maps for the entire area may be available.

4. Location of Known Faults - Enter in order of proximity the major active faults in the vicinity of the site of the building being surveyed. If a building is located in a region where a network of faults exists, list the three major active faults within a 100 mile radius from the site. Information on fault locations and whether faults are active or dormant can be obtained from state maps prepared by the U. S. Geological Survey. These maps are available from the USGS Libraries located at Menlo Park, California; Denver, Colorado; and Washington, D.C. These maps are also usually on file in offices of the Division or Department of Geology in each state.

5. Depth of Water Table - Enter number of feet. This information can be obtained from building plan or from a local structural or soils engineering office.

6. Depth of Bedrock - Enter number of feet. This information can be obtained from building plan or from a local soils engineering office.

7. & 8. Soil Type and Bearing Capacity - Information regarding these items can be obtained from building plan or from a local soils engineering office.

9. Wind Blown Debris - Potential wind blown debris from outside the building should be noted, where it can be observed by a look around the facility to be evaluated. Material such as lumber, junk yards, piles of sand or gravel are potential missiles in a tornado or other windstorm. Light sheds may be wind transported. Even gravel blown from adjoining roofs can cause damage. The presence of any material that is such a potential hazard should be noted with approximate locations and distance. Investigation of this, from a practical standpoint is limited to a distance of 100 yards from the building in urban built-up areas and the area within view of the facility in open or rural areas.

C. STRUCTURAL SYSTEMS

1. & 2. Material and Vertical Load Resisting Systems - The material used for the mainload carrying members. For example, for frame structures, identify whether beams and columns are made of concrete, steel, or timber. For load-bearing structures, identify whether the wall is made of concrete or masonry. Care must be exercised in determining this entry. Frequently, frame structures have brick-veneer cladding as shown in figure A.13a. These structures appear as masonry load-bearing structures. However, a large number of openings in the wall in all four elevations could serve as a clue that these walls cannot be load-bearing walls. It is apparent from Figure A.13b that the building is a concrete frame structure. A clue for load-bearing structures is that while a building may have many window openings, some portions of the wall which carries the vertical load must be solid and usually extend continuously through the height of the structure as shown in figure A.14. Unless a building has metal curtain walls, the exterior appearance does not usually lend itself to identifying whether the structure is made of steel or concrete. Correct identification can be made only when observations are made of exposed frames as shown in figure A.15.

3. Lateral Load Resisting System - Refer to description given for Items 20, 21, 23, and 24.

4. Floor System - Common floor systems used in engineering buildings are illustrated in figures A.16 through A.21. Unless the underside of the floor is exposed for visual examination, it is necessary to examine the space between the ceiling and the bottom of the floor above to determine types of framing and decking. For the suspended ceiling with acoustical tiles, this can easily be accomplished by lifting one of the tiles and examining the underside of the floor. For the suspended ceiling with lath and plaster, an examination can be made through inspecting openings which are usually provided in the ceiling for checking utility systems.

Connections - Unless it is a steel frame structure, the types of structural connections used are difficult to determine. For concrete frame structures, monolithic connections are used. For steel frame structures, one of the three connections illustrated in figure A.22 can be expected. They are riveted, bolted, and welded connections. Some connections use combinations of these fastening techniques as illustrated in figure A.23.

Anchorage - The anchorage of floors to walls (either bearing walls or shear) walls is to be noted. The anchorage between cast-in-place concrete floors and walls is usually satisfactory but cannot be checked by visual observation. The anchorage of metal decks to steel frame elements of walls is usually through welds or screws which cannot be seen in the completed structure. Metal decks with concrete topping slabs may have dowels extending into masonry or concrete walls, but here again these cannot be seen by the field team. If plans are available, the type and spacing of anchors should be shown.

In cases where there is a wood floor and no ceiling, some types of anchors may be visible and the type and spacing noted. Similarly, where no ceilings occur or where there is sufficient crawl space above the ceiling, the anchorage of steel frame members to the walls may be seen and noted. Even in such cases that portion of the anchors embedded in the walls cannot be seen. Figure A.19 shows a typical open web joist anchor detail.

If the type and spacing of anchorage can be determined, either from observation or from plans, fill in the appropriate box. A small sketch at the side may help describe the type. If the anchorage type and spacing cannot be determined from either observation or plans, mark "unknown" under the anchorage item.

5. Roof System - Structural framing system of the roof is usually essentially the same as the floor system. Instead of a flooring surface consisting of concrete, the roof usually has rigid insulation boards as illustrated in figures A.24 and A.25. Similar to the case of the floor, the roof framing has to be determined from the story below through the ceiling. It is probable that the same types of connection details are used for the roof framing members as for the floor framing members.

   The same comments and instructions given for Floor System anchorage are applicable to Roof System anchorage.

D. NONSTRUCTURAL ELEMENTS

1. Partition (non-load bearing) - In concrete or steel frame structures, non-load bearing interior partitions are not designed to resist any loads, either vertical or horizontal. However, when structures having masonry partitions are subjected to lateral forces, these partitions participate in resisting lateral forces together with the structural frame. Such partitions may change the structural response characteristics to such an extent that the structure either sustains severe damage or reaches a state of collapse. These partitions, also called "infill walls," are usually made of brick, concrete block, clay tile and gypsum wallboard partitions. Gentle tapping of a partition with a solid object helps to identify the gypsum wallboard partitions from the rest. This tapping technique can also be used to identify lath and plaster on studs.

2. Ceiling - The most common materials used for ceiling include acoustical tiles, gypsum board, and plaster. Acoustical tiles and plaster on lath are usually used in commercial buildings, whereas gypsum boards are commonly used in residential-type structures such as apartments, dormitories, etc. Both acoustical tile and lath and plaster ceilings are either attached directly to the structural members or suspended from them, while gypsum board ceilings are directly attached to structural members. The typical appearance of acoustical tile ceilings is shown in figure A.26. Directly attached and suspended acoustical tile ceilings are illustrated in figure A.27 and lath and plaster ceilings in figure A.28.

3. Light Fixtures - Check one of the three methods which describe the fixture attachment (see figure A.29). This should be done separately for the typical room and corridor.

4. Mechanical Equipment - Enter the location of the mechanical equipment room. Examine whether or not heavy equipment, such as motor, pump, generator, etc., is securely attached to the floor. Usually the supporting legs of heavy equipment are anchored to the floor by means of anchor bolts. If anchor bolts are not found, it is assumed that the equipment is not fastened to the floor.

   Indicate where the water tank, cooling tower, and air conditioning units are located and examine whether or not these items are securely anchored.

5. Roofing - Indicate the slope of the roof. If flat, simply indicate by checking the appropriate box. If the roof has a slope, estimate the vertical rise per foot. If gravel is placed on the roof, gravel stops are usually used instead of a parapet (see figure A.30). The height of the parapet if present is to be measured as illustrated in figure A.31. Examine whether or not the parapet is anchored to the roof by means of anchor straps (figure A.32 or by other means).

6. Windows - The windows can be categorized broadly as fixed windows and movable windows. Fixed windows are those which cannot be opened. Usually these windows have a large single pane of glass. Movable windows are those which can be opened as illustrated in figure A.33. Frames for both fixed and movable windows are made of different material. Check one of the materials indicated.

   The sizes of casing and glazing are illustrated in figure A.34. If more than one type of window of each category is used, select the predominant one to measure the size.

   The method of attachment of the casing to the structure is seldom apparent from a cursory inspection. Unless the method of attachment can be obtained readily by visual inspection, enter "unknown."

   The glazing is usually placed in the window casing by means of an elastometric gasket or glazing compound.

7. Gas Connections - In areas subjected to severe earthquakes, a type of gas connection has been developed which permits the building to vibrate independently from the gas line so as not to break the gas line. These connections utilize flexible connections and may have an automatic shut-off valve. Such a connection will usually be before the gas meter but adjacent to the building and may be in a pit or in a box or may be buried. The type of connection may or may not be visible for inspection but the building manager may know whether or not an earthquake resistant connection has been provided. Some buildings, of course, may be all electric and use no gas. If so, this should be noted by a check in the "none" box.

A.3 DATA COLLECTION FORM

The remaining pages of this appendix present the data collection form used in this methodology.

DC-1

DATA COLLECTION FORM
NATURAL HAZARDS EFFECTS
(Extreme Winds, Earthquakes)

A. GENERAL DATA

*1. Facility No. _______ 2. Building Name ____________________________

3. Address ________________________________ 4. City ________________

5. State __________________ 6. Zip Code _______ 7. Year Built _______

8. Date of Major Modifications or Additions, if any ____________________

9. Building Code Jurisdiction: City ☐ County ☐ State ☐ Federal ☐

*10. Latitude ______________________ *11. Longitude ____________________

12. Current Bldg. Use ___________ Orig. Bldg. Use ____________________

13. Basement Yes ___ No ___ Number of Basements _________________

No. of Stories Above Basement ______________ (See also Item A23)

14. Height of First Story ________________ ft.

15. Upper Story Height ____________ ft. Special Story Height ________ ft.

16. Is the exterior of first story different from upper stories?

Street Front Side Yes ___ No ___ Other Sides Yes ___ No ____

17. Approximate Roof Overhang Distance ___________ Side _________________

18. Proximity to Adjacent Buildings: Sketch Below with North Arrow

North Side ______ South Side ______ East Side ______ West Side _____

Note Street or Alley Sides ______________________________________

*To be filled in by Field Supervisor.

Sketch

19. Are plans available? _____ If so, where obtainable ________________

________________ Are original calculations available? _____ If so,

where obtainable ____

Name of: Architect ________________ Engineer ________________

Contractor ____

Regulatory Agency ____________________________________

20. Basic Building Plan

a. Sketch overall plan.
b. Locate shear walls, if any.
c. Locate main frames.
d. Locate expansion joints, if any.
e. Give approximate north arrow and label sides "A", "B", "C", "D", etc. Show street or alley sides.
f. Note any common or party walls.
g. If plan changes in upper floors, sketch this plan and note level of change.

(Use additional sheet if necessary)

21. Elevation of Exterior Walls.

Sketch:
- a. All openings or note pattern of openings.
- b. Note exterior finish and appendages.
- c. Note material of walls.
- d. Major cracks or other damage. (Note if cracks are larger at one end.)
- e. Note previously repaired damage.
- f. Note any evidence of damage to cladding or appendages.

(Use additional sheet if necessary)

22. Elevation of Interior Shear Walls.

Sketch:
- a. All openings.
- b. Major cracks or other damage. (Note if cracks are larger at one end.)
- c. Note any previously repaired damage.

23. Adaptability of Basement to Storm Shelter.

a. Floor Over Basement - Concrete ☐ Other ☐

b. If concrete, give thickness ________

c. Available Space (approximate) ________________ sq. ft.

d. Dangerous Contents. Storage of Flammable Liquids ☐

Presence of Transformers or Other Dangerous Equipment ☐

Other Hazards ____

None ☐

24. Is this a Vault-like Structure? Yes ☐ No ☐

25. EXTERIOR WALL SUMMARY SHEET

Exterior Characteristics	Side A	Side B	Side C	Side D
Extensive Architectural Ornaments or Veneer				
WALLS Metal Curtain Wall				
Precast Concrete Curtain Wall				
Stone				
Brick				
Concrete Block				
Concrete				
Other				
For Concrete Block and Brick, indicate R for Running Bond S for Stacked Bond				
Condition of Wall*				
OPENINGS Percent of Open Area per Story				

*1. No cracks, good mortar.
2. Few visible cracks.
3. Many cracks
4. Evidence of minor repairs.
5. Evidence of many repairs.

B. SITE RELATED INFORMATION

1. Exposure

   a. Centers of large city ☐ b. Very rough hilly terrain ☐

   c. Suburban areas, towns, city outskirts, wood areas, or rolling terrain ☐ d. Flat, open country ☐

   e. Flat coastal belts ☐ f. Other ☐

2. Topography

   a. Building on level ground ☐ b. Building on sloping ground ☐

   c. Building located adjacent to embankment ☐

*3. Geologic formation ____________________

*4. Location of known faults: Name ____________ Miles ______

____________________ Miles ______

*5. Depth of water table ________ ft. When measured: ____________ (Month) (Year)

*6. Depth of bedrock ________ ft.

*7. Soil type ____________________

*8. Bearing capacity __________ p.s.f., or __________ blows per inch

9. Proximity to potential wind-blown debris - Type ____________

Location ____________________ Distance ____________

---

*To be filled in by Field Supervisor.

C. STRUCTURAL SYSTEMS

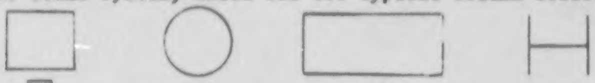
1. Material

Concrete ☐ Masonry ☐ Steel ☐ Wood ☐

2. Vertical Load Resisting System

Frame ☐ Bearing Wall ☐ Wall and Pilasters ☐

For frame system, check one for typical column cross-section



☐ ☐ ☐ ☐ Other ☐

3. Lateral Load Resisting System

Masonry Shear Wall ☐

Concrete Shear Wall ☐

Plywood Shear Wall ☐

Braced Frame ☐

Moment Resisting Frame ☐

Are resisting systems symmetrically located? ☐ Yes ☐ No

4. Floor System

Frame

Concrete Beams ☐

Steel Beams ☐

Steel Bar Joist ☐

Wood Beams ☐

No Framing Members ☐

Precast Concrete Beams ☐

Deck

Concrete Flat Plate ☐

Concrete Flat Slab ☐

Concrete Waffle Slab ☐

Steel Deck ☐

Wood Joists ☐

Wood Plank ☐

Straight Sheathing ☐

Plywood Sheathing ☐

Diagonal Sheathing ☐

Precast Concrete Deck ☐

Concrete Joists ☐

Concrete Plank ☐

Note if concrete topping slab is used over metal decks or concrete plank.

Connection Details

	Framing	Decking To Framing
Bolted	☐	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Floor to Walls

Type ____________________

Spacing ____________________

5. Roof System

Frame

Concrete Beams ☐

Steel Beams ☐

Steel Bar Joist ☐

Wood Beams ☐

Wood Rafters ☐

Steel Truss ☐

Wood Truss ☐

No Framing Members ☐

Precast Concrete Beams or Tees ☐

Deck

Concrete Flat Slab ☐

Metal Decking ☐

Concrete Slab ☐

Concrete Joists ☐

Precast Decking ☐

Concrete Waffle Slab ☐

Plywood Sheathing ☐

Diagonal Sheathing ☐

Straight Sheathing ☐

Concrete Fill Yes ☐ No ☐

Connection Details

	Framing	Docking to Framing
Bolted	☐	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Roof to Walls

Type ______________________________

Spacing ______________________________

D. NONSTRUCTURAL ELEMENTS

1. Partitions

Type

	Typical	Corridor
Partial Height	☐	☐
Full Height Floor-To-Ceiling	☐	☐
Floor To Floor	☐	☐
Movable	☐	☐

Composition

Lath and Plaster ☐

Gypsum Wallboard ☐

Concrete Block ☐

Clay Tile ☐

Metal Partitions ☐

2. Ceiling

Typical Room

Material

Acoustical Tile ☐ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☐ Metal Channels ☐ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

Typical Corridor

Material

Acoustical Tile ☐ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☐ Metal Channels ☐ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

3. Light Fixtures

Typical Room

Recessed ☐ Surface Mounted ☐ Pendant (Suspended) ☐

Typical Corridor

Recessed ☐ Surface Mounted ☐ Pendant (Suspended) ☐

4. Mechanical Equipment

Location of Mechanical Equipment Room

Basement ☐ Other Floor ☐ Which Floor ______

Roof ☐

Is Equipment Anchored to Floor? No ☐ Yes ☐

Location of The Following Units

Liquid Storage Tank ________________________________

Cooling Tower ________________________________

Air Conditioning Unit ________________________________

5. Roofing

Description

Flat ☐ Arched ☐ Gabled ☐ If arched or gabled, sketch section.

Pitched ☐ Slope (:12)

Parapet No ☐ Yes ☐ Height (______ ft. ______ in.) Thickness (____ in.)

Material ______________ Special Anchorage or Bracing Yes ☐ No ☐

Type

Built-up gravel ☐ Gravel ☐ Asphalt or Wood Shingles ☐

Clay Tile ☐ Other ☐

6. Windows

Type

Fixed ☐ Movable ☐

Frame Material:

Aluminum ☐ Steel ☐ Stainless Steel ☐ Wood ☐

Size: Average Size of Casing (____ ft. x _____ ft.)

Average Size of Glazing (____ ft. ____ in. x ____ ft. ____ in.)

How Casing is Attached to Structure

Bolted ☐ Screwed ☐ Clipped ☐ Welded ☐ Nailed ☐

Glazing Attachment to Casing

Elastomeric Gasket ☐ Glazing Bead ☐ Aluminum or Steel Retainer ☐

Other ☐

7. Gas Connection

Flexible Connection to Building ☐ Rigid Connection to Building ☐

Automatic Shut-off ☐ None ☐ Unknown ☐

INSPECTED BY ______________________________

DATE ______________________________

FIELD SUPERVISOR ______________________________

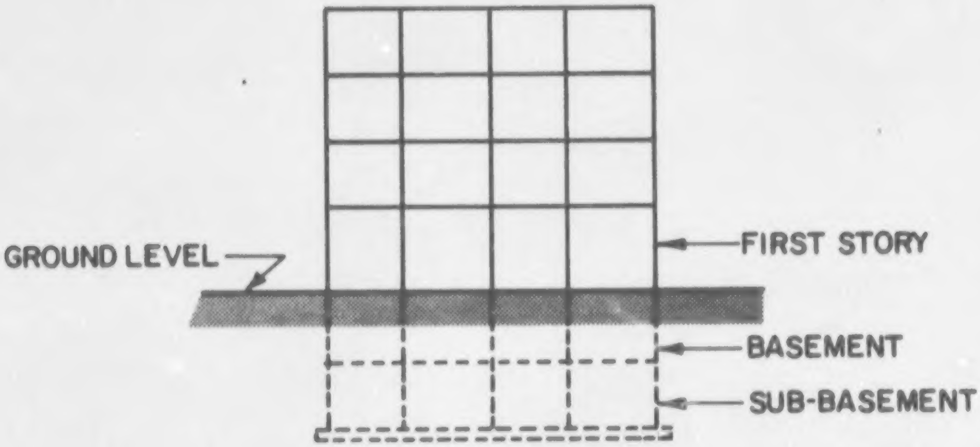

GROUND LEVEL
FIRST STORY
BASEMENT
SUB-BASEMENT

Figure A.1

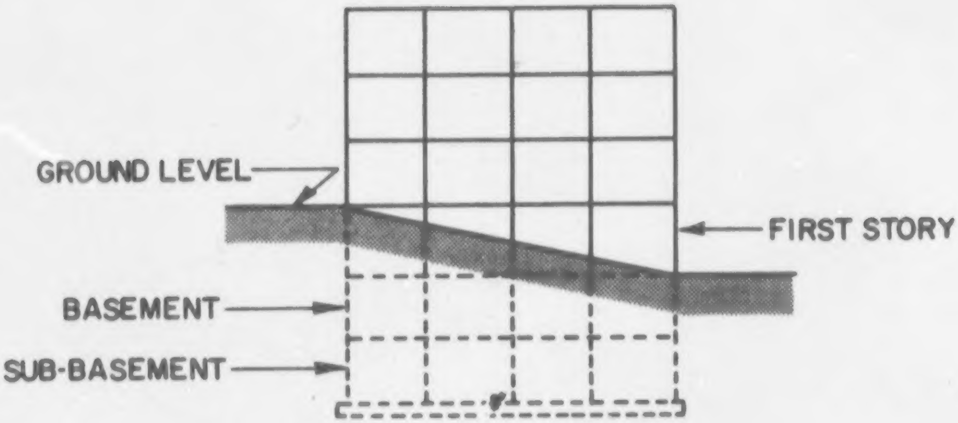

GROUND LEVEL
FIRST STORY
BASEMENT
SUB-BASEMENT

Figure A.2

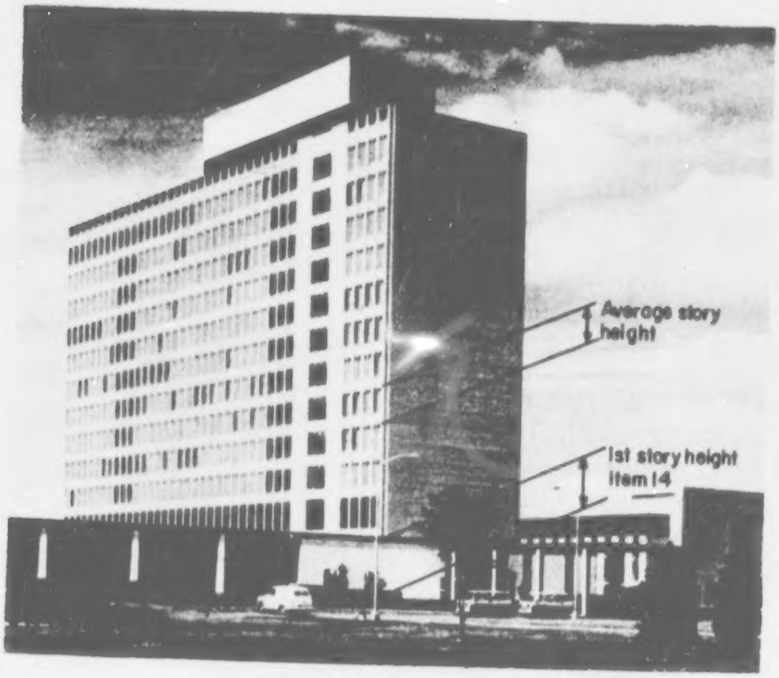

Average story height
1st story height
item 14

Figure A.3

Figure A.4

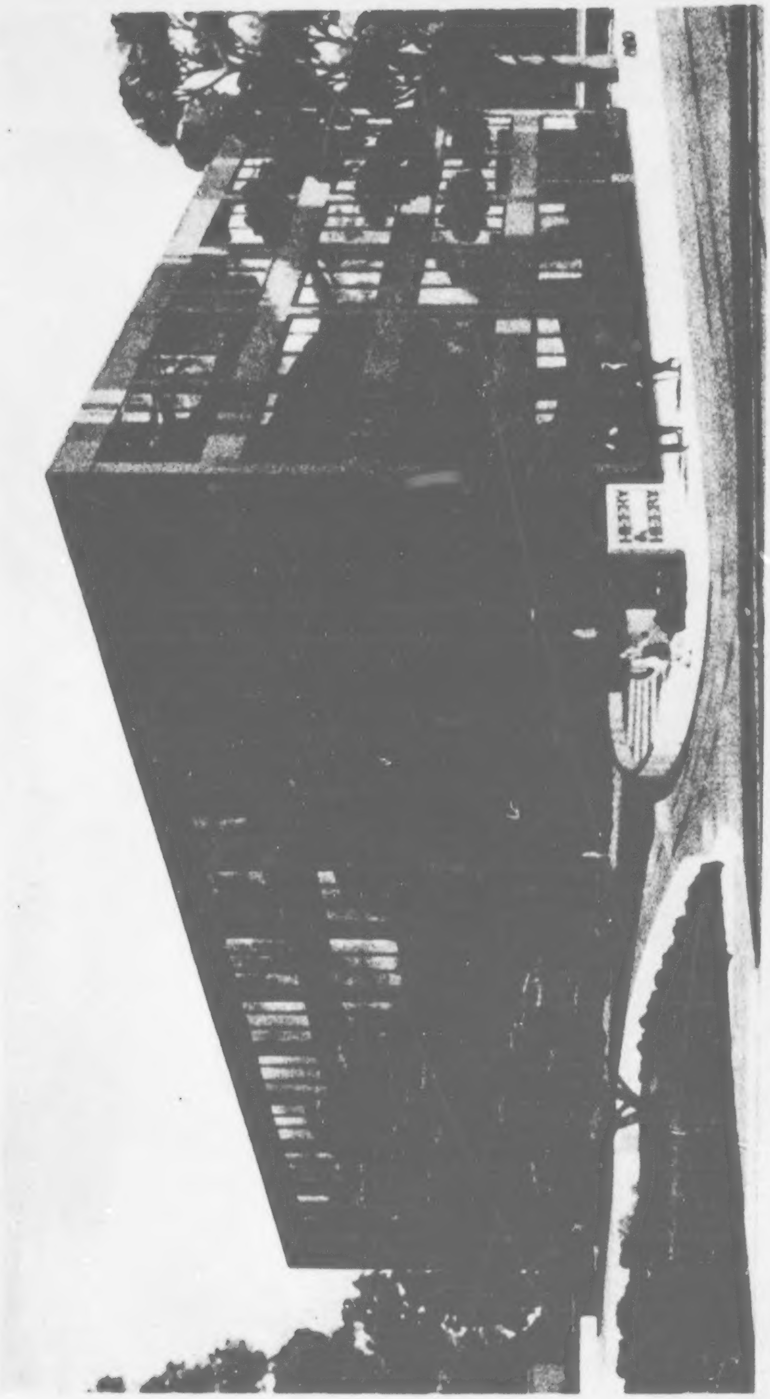
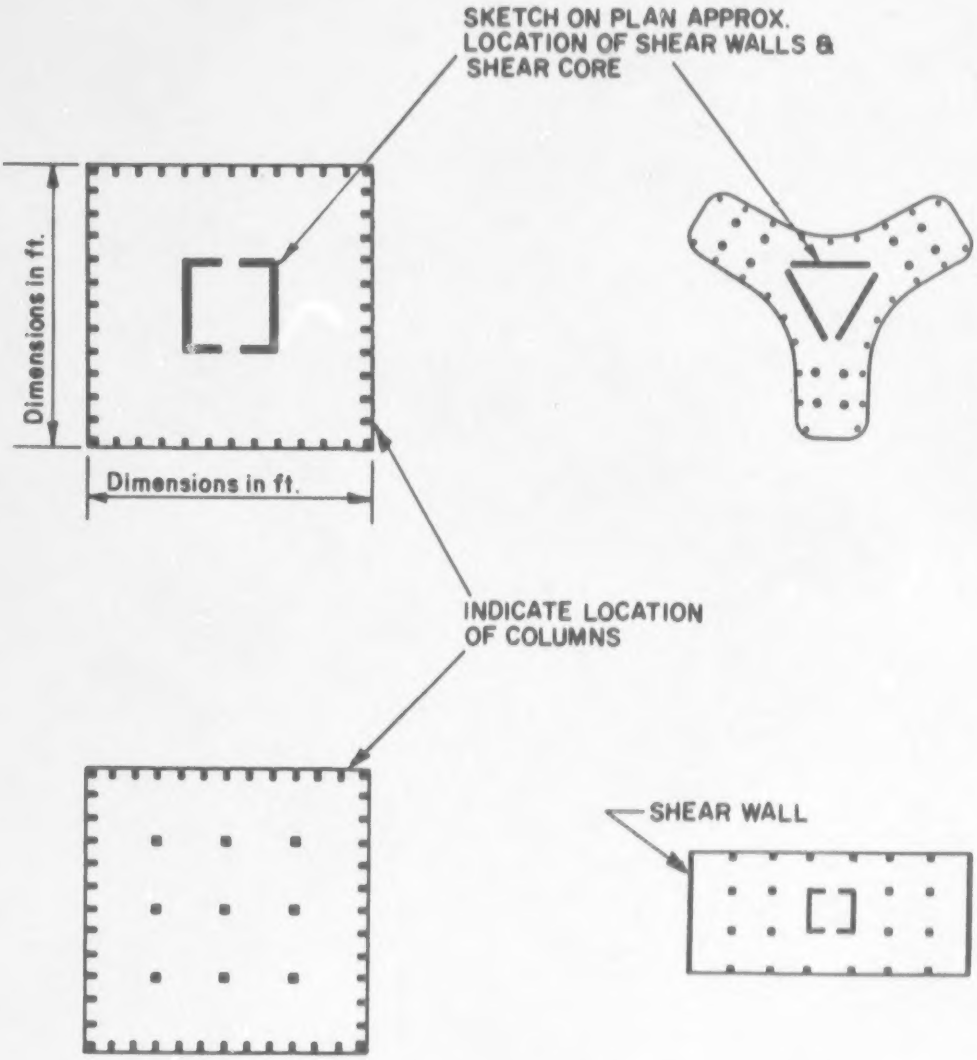


Figure A.5



SKETCH ON PLAN APPROX. LOCATION OF SHEAR WALLS & SHEAR CORE

INDICATE LOCATION OF COLUMNS

Dimensions in ft.
Dimensions in ft.
SHEAR WALL

INDICATE ON PLAN WHETHER THE SHEAR WALL AND CORE ARE REINFORCED CONCRETE OR MASONRY

Figure A.6

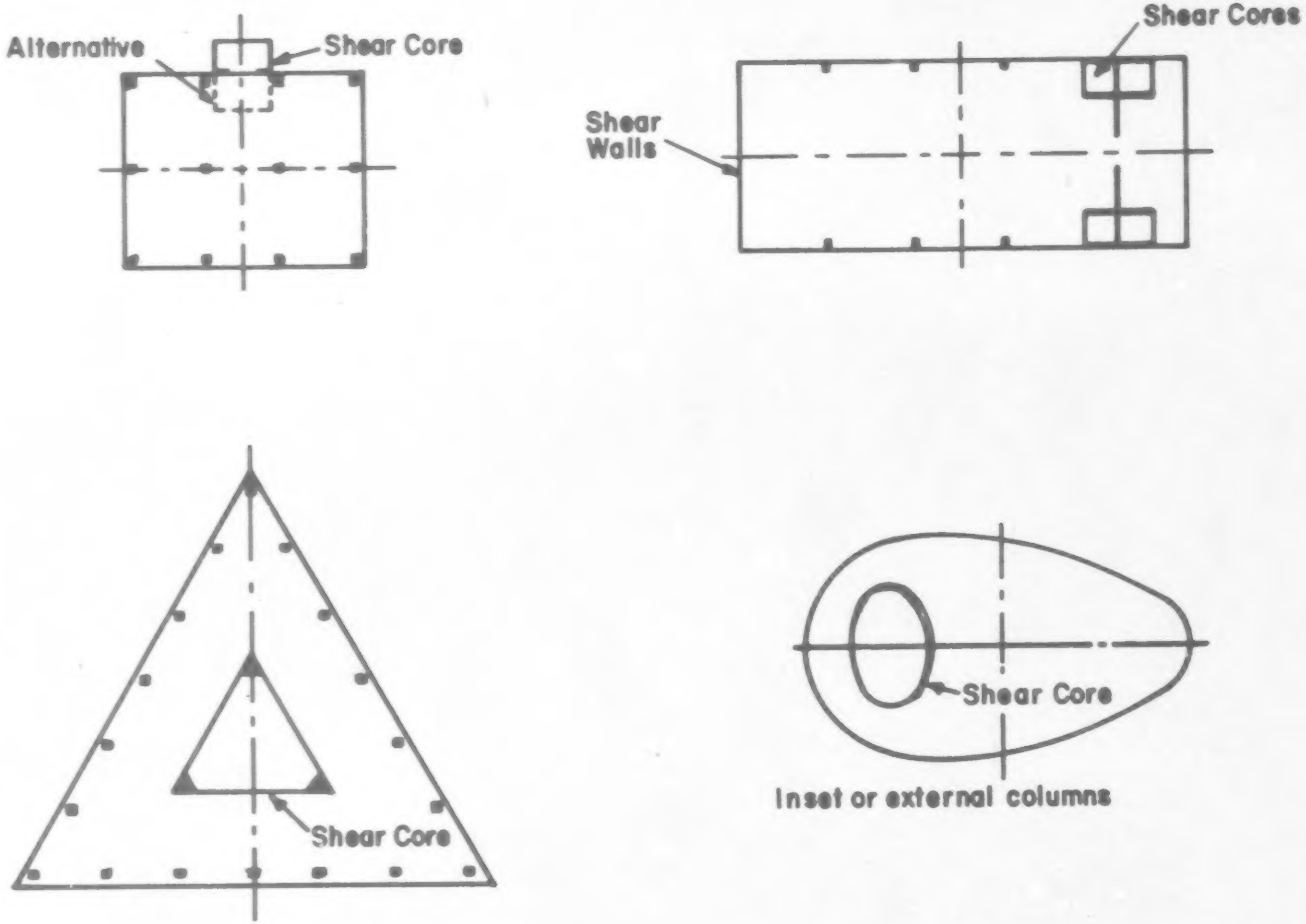
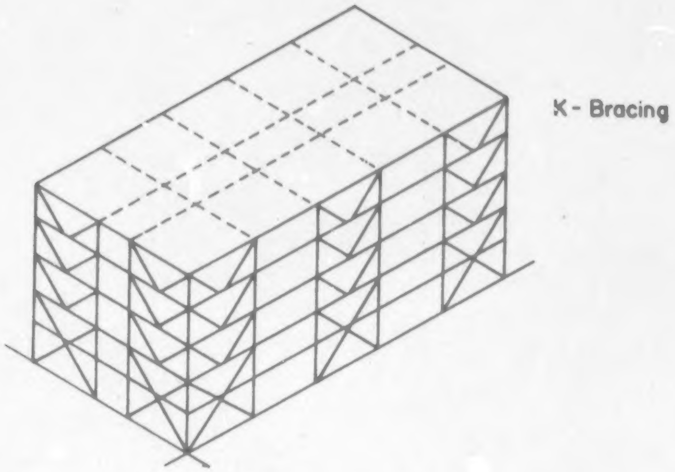
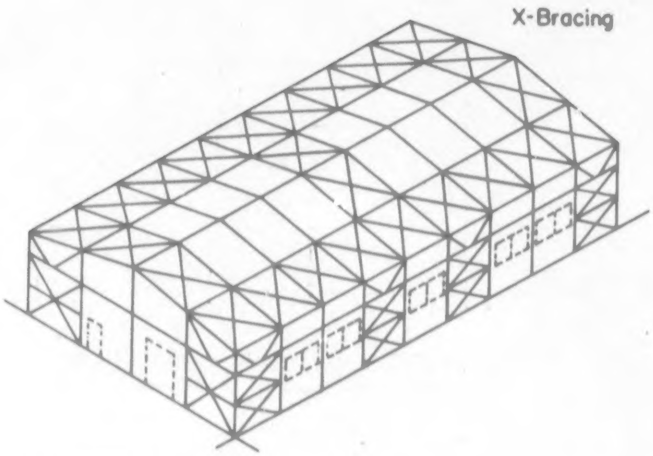

Alternative
Shear Core
Shear Cores
Shear Walls
Shear Core
Inset or external columns
Shear Core

Figure A.7

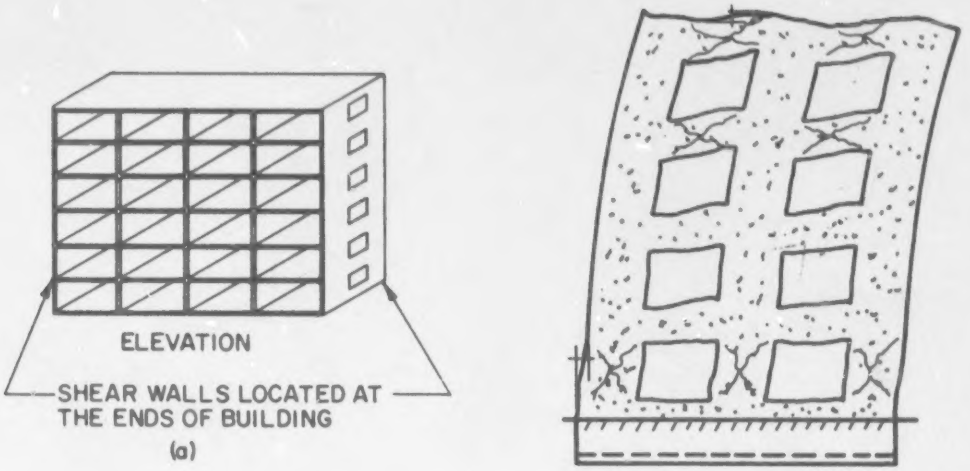


BRACING FOR A TIER BUILDING



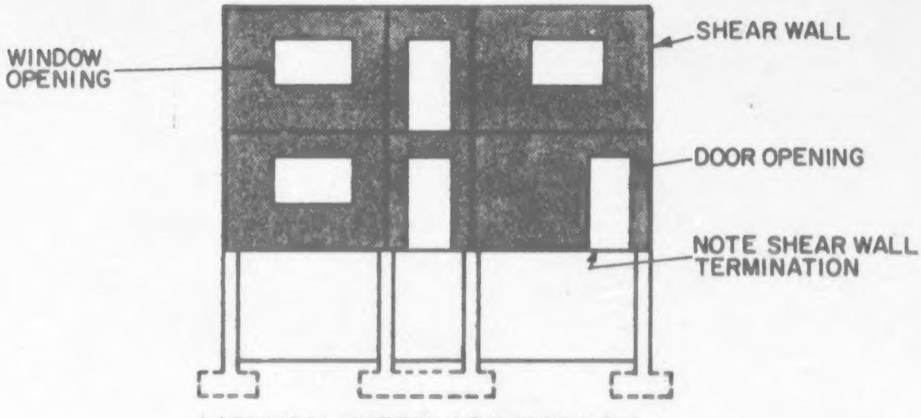
BRACING AN INDUSTRIAL BUILDING

Figure A.8


ELEVATION
SHEAR WALLS LOCATED AT THE ENDS OF BUILDING

(a)

(b) DEFORMATION OF SHEAR WALL WITH OPENINGS


WINDOW OPENING
SHEAR WALL
DOOR OPENING
NOTE SHEAR WALL TERMINATION

(c) TYPICAL SKETCH OF SHEAR WALL ELEVATION WITH DOOR AND WINDOW OPENINGS

THIS TYPE OF SKETCH IS REQUIRED FOR ITEM A.

Figure A.9

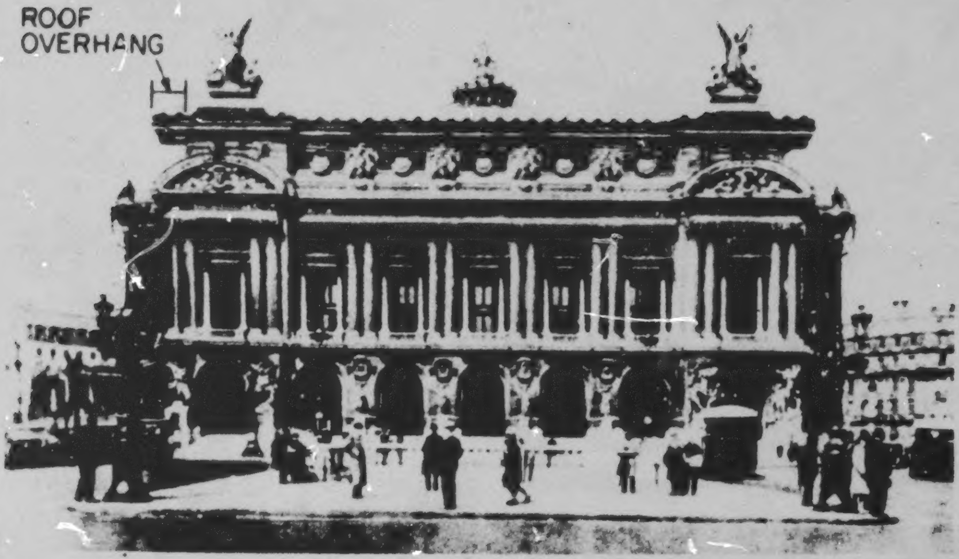

ROOF
OVERHANG

Figure A.10

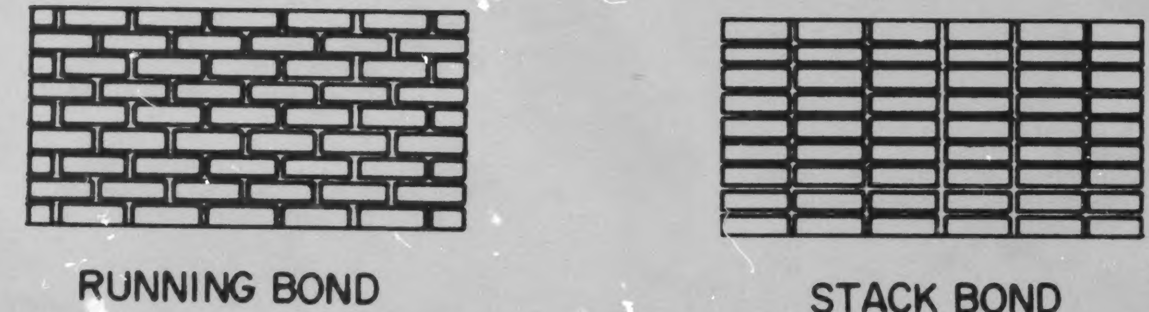

RUNNING BOND
STACK BOND

Figure A.11

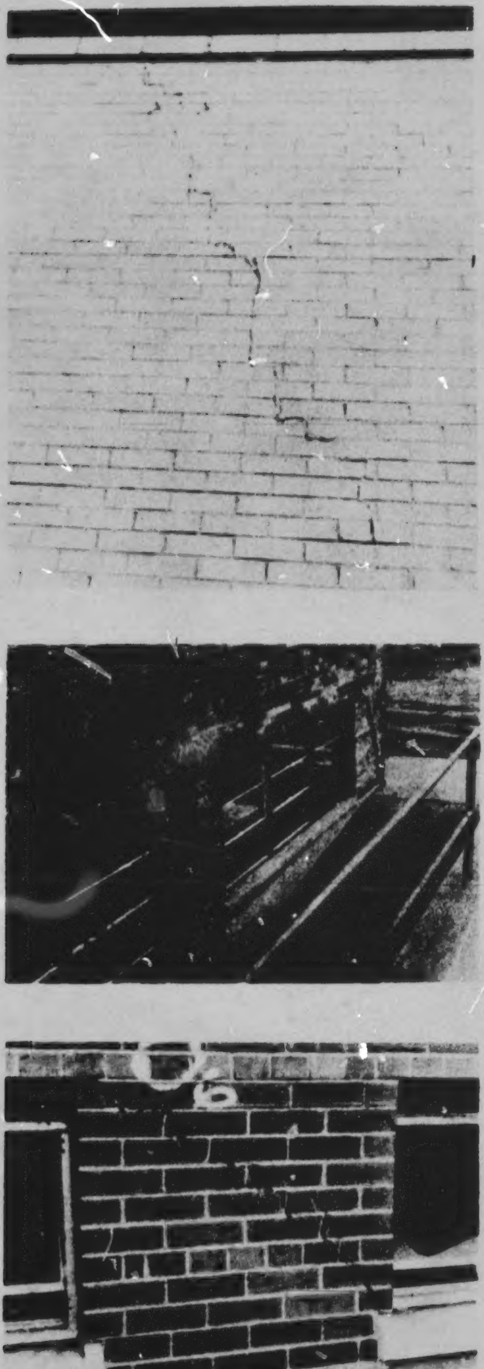
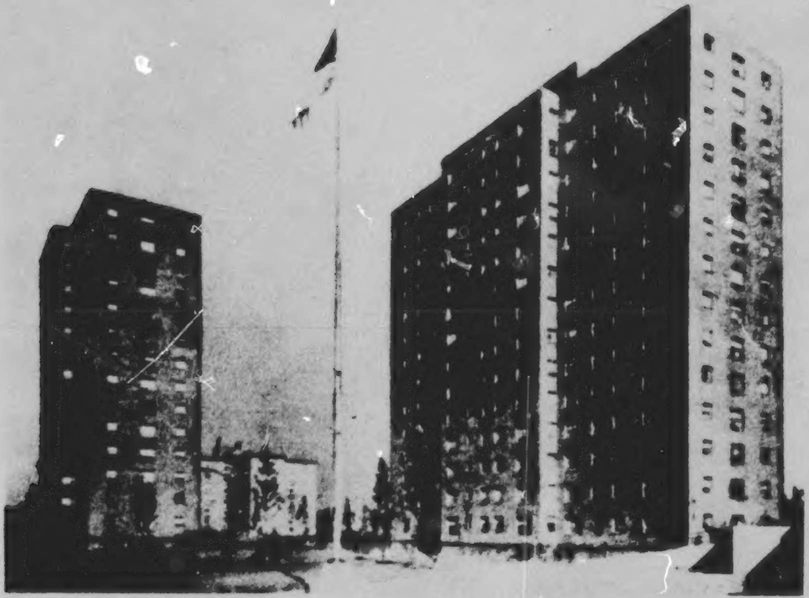
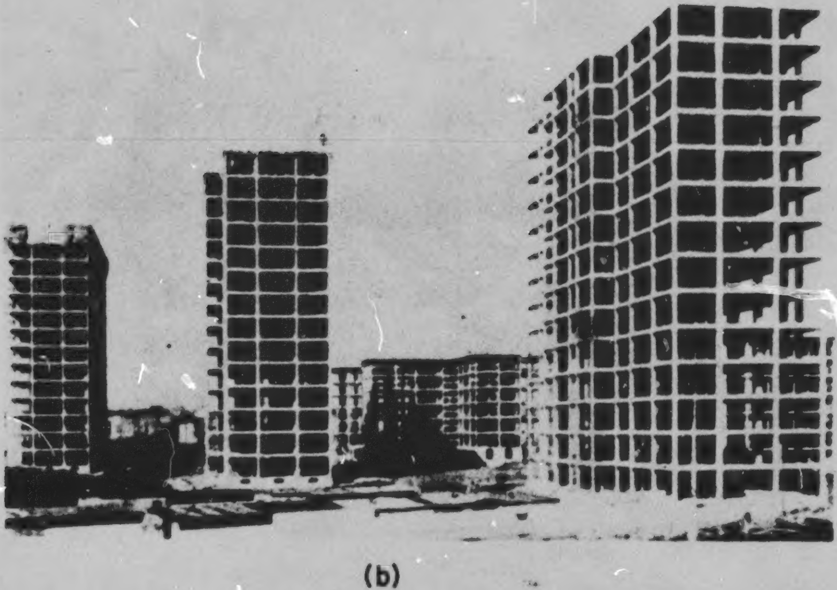


Figure A.12



(a)



(b)

Figure A.13

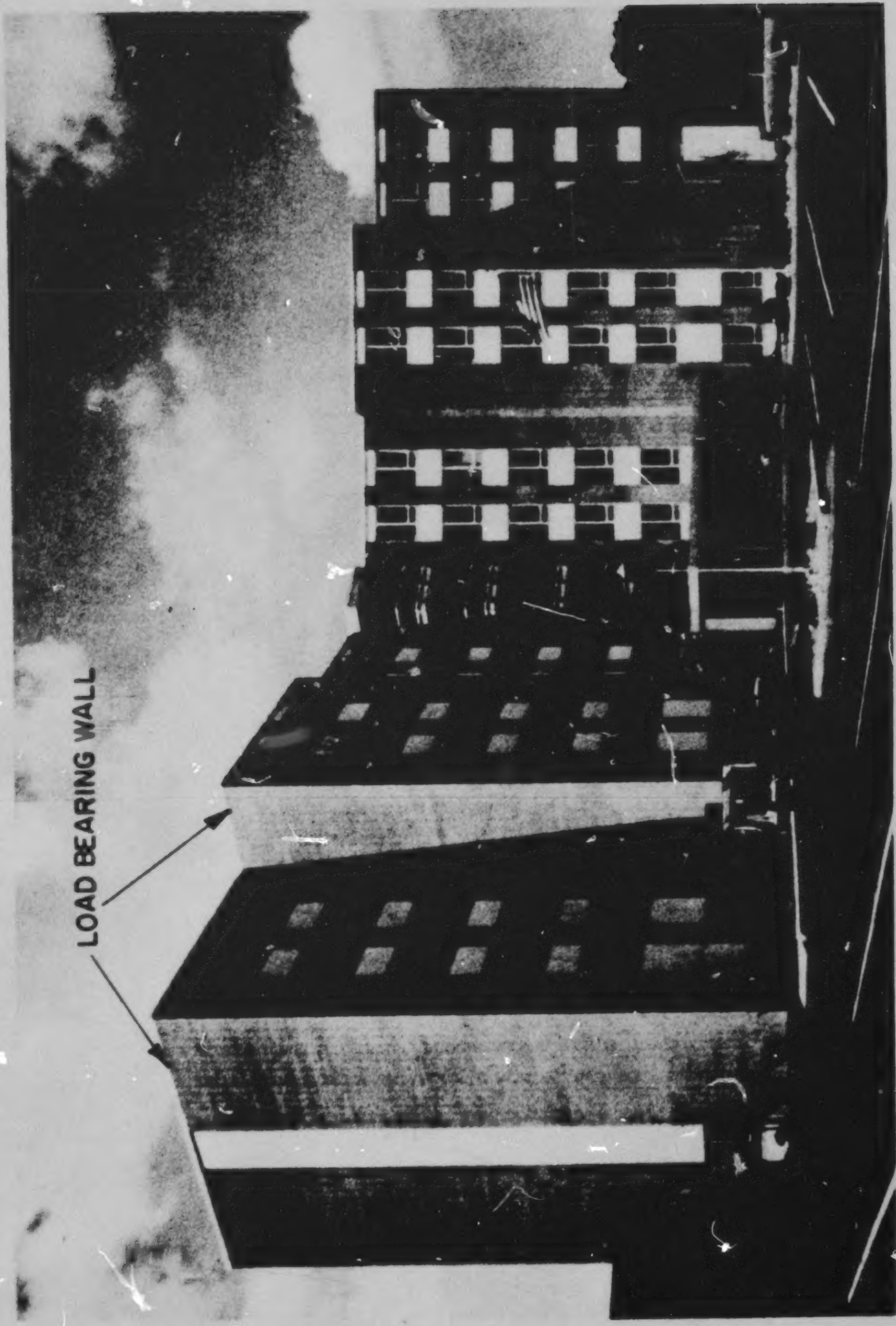
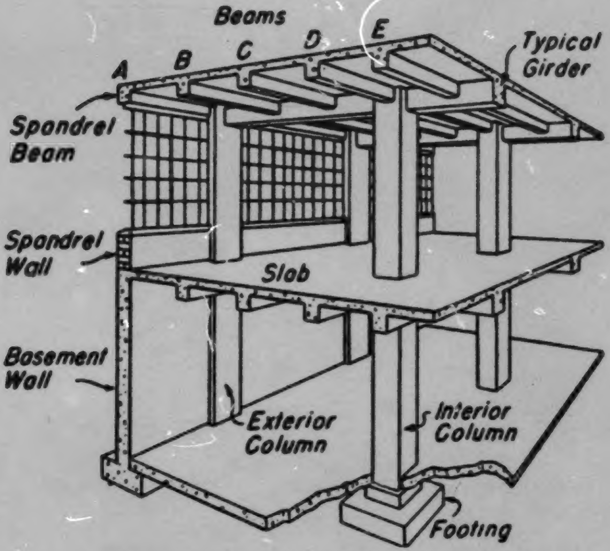
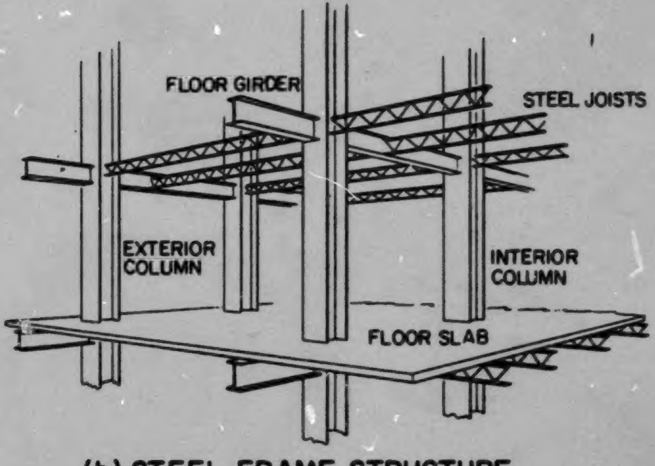

LOAD BEARING WALL

Figure A.14

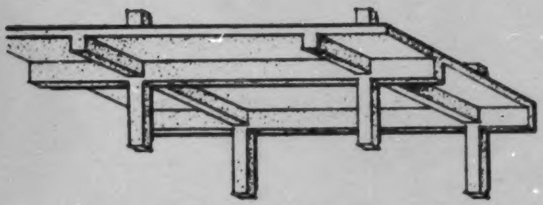

Beams
A
B
C
D
E
Typical Girder
Spandrel Beam
Spandrel Wall
Slab
Basement Wall
Exterior Column
Interior Column
Footing

(a) CONCRETE FRAME STRUCTURE

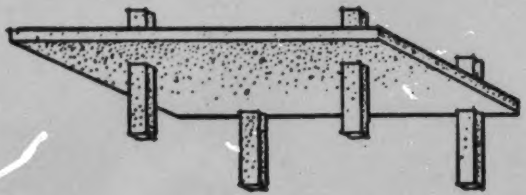

FLOOR GIRDER
STEEL JOISTS
EXTERIOR COLUMN
INTERIOR COLUMN
FLOOR SLAB

(b) STEEL FRAME STRUCTURE

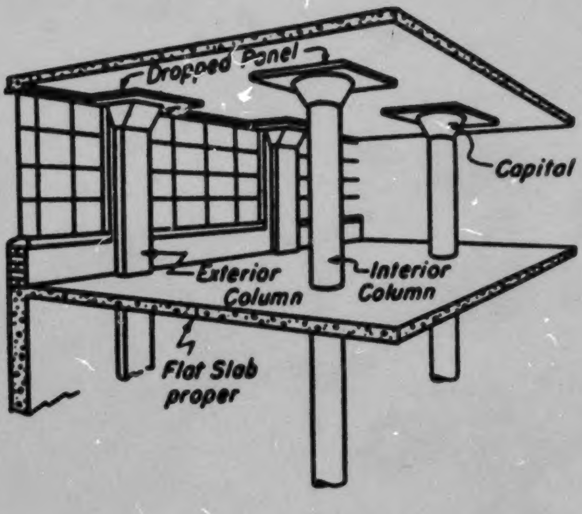
Figure A.15



CONCRETE BEAMS; GIRDERS AND SLAB SYSTEM

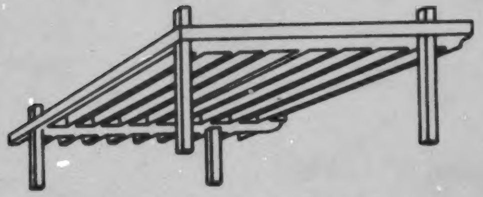


FLAT PLATE CONSTRUCTION


Dropped Panel
Capital
Exterior Column
Interior Column
Flat Slab proper

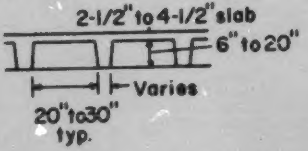
FLAT SLAB CONSTRUCTION

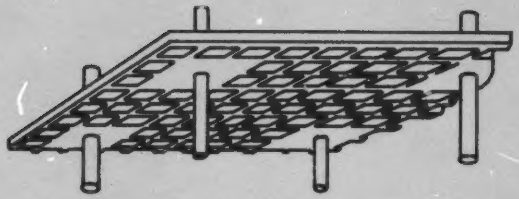
Figure A.16



ONE WAY JOIST-SLAB FLOOR CONSTRUCTION

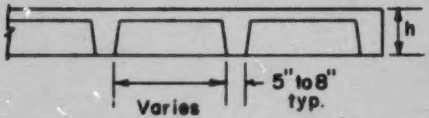
ONE WAY JOIST-SLAB FLOOR SYSTEM

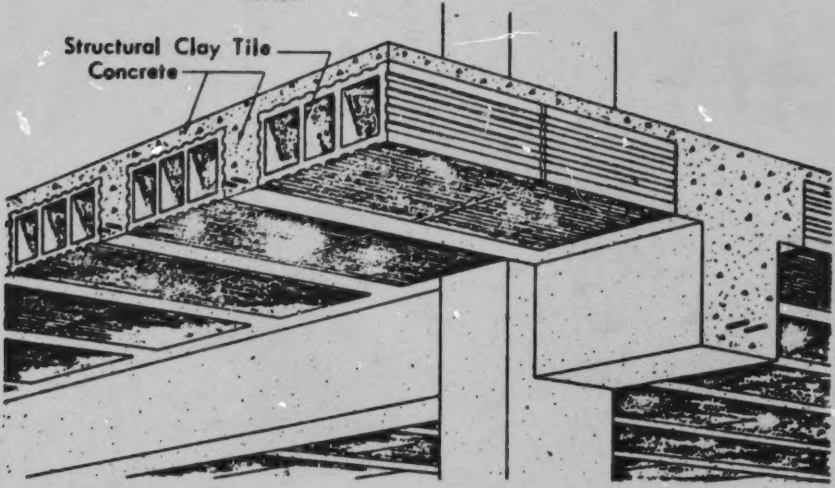

2-1/2" to 4-1/2" slab
6" to 20"
Varies
20" to 30" typ.



WAFFLE-SLAB FLOOR CONSTRUCTION

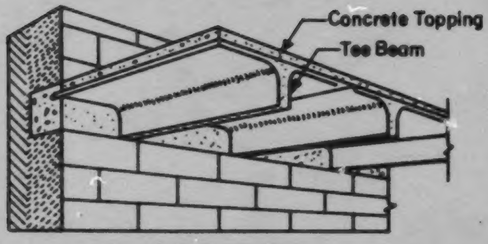
WAFFLE SLAB FLOOR SYSTEM


h
Varies
5" to 8" typ.


Structural Clay Tile
Concrete

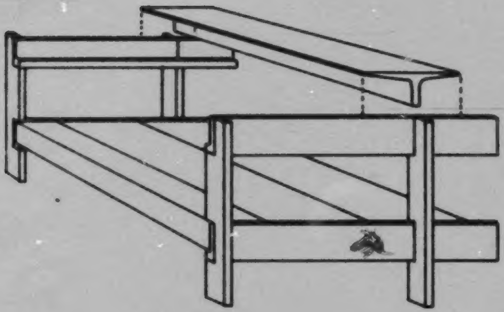
Combination Clay Tile and Concrete Slab

Figure A.17

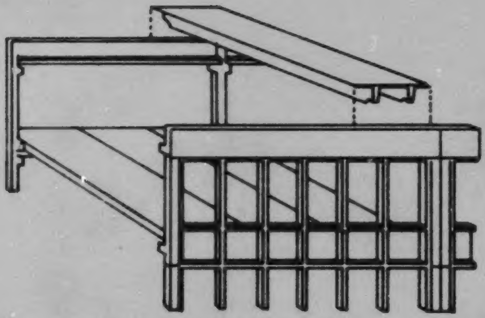

Concrete Topping
Tee Beam

CONCRETE TEE BEAMS

SINGLE-T FLOOR CONSTRUCTION WITH LOAD-BEARING WALL



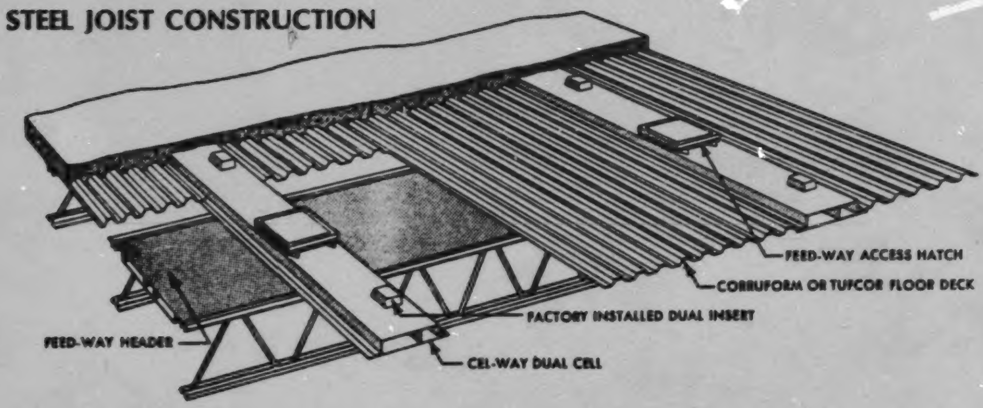
SINGLE-T FLOOR CONSTRUCTION WITH CONCRETE FRAME BUILDING



DOUBLE-TEE FLOOR SYSTEM

DOUBLE-T FLOOR CONSTRUCTION

Figure A.18


STEEL JOIST CONSTRUCTION
FEED-WAY ACCESS HATCH
CORRUFORM OR TUFCOR FLOOR DECK
FACTORY INSTALLED DUAL INSERT
FEED-WAY HEADER
CEL-WAY DUAL CELL

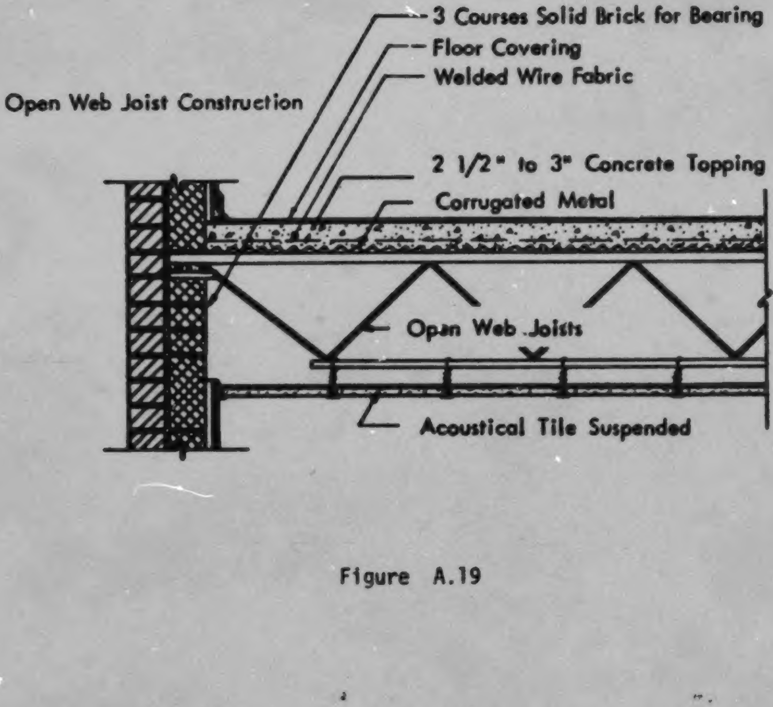

3 Courses Solid Brick for Bearing
Floor Covering
Welded Wire Fabric
Open Web Joist Construction
2 1/2" to 3" Concrete Topping
Corrugated Metal
Open Web Joists
Acoustical Tile Suspended

Figure A.19

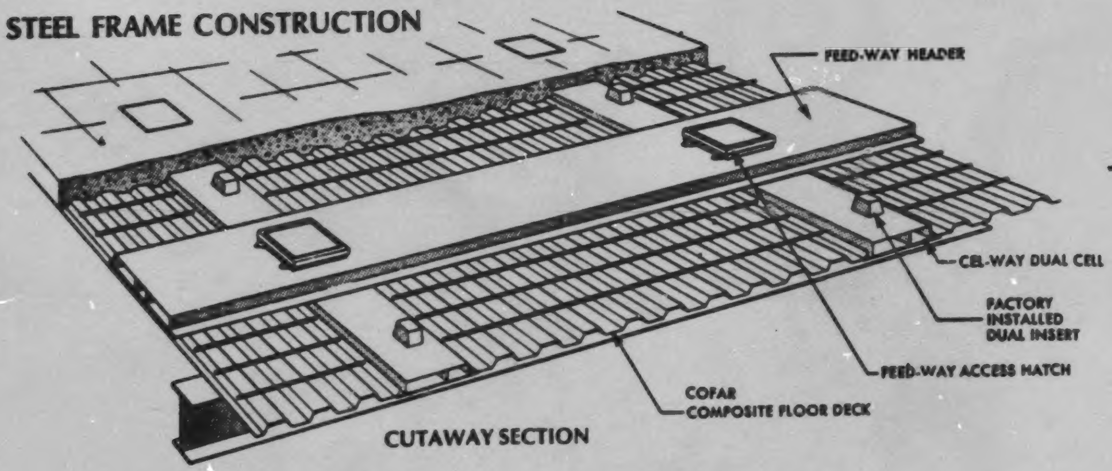
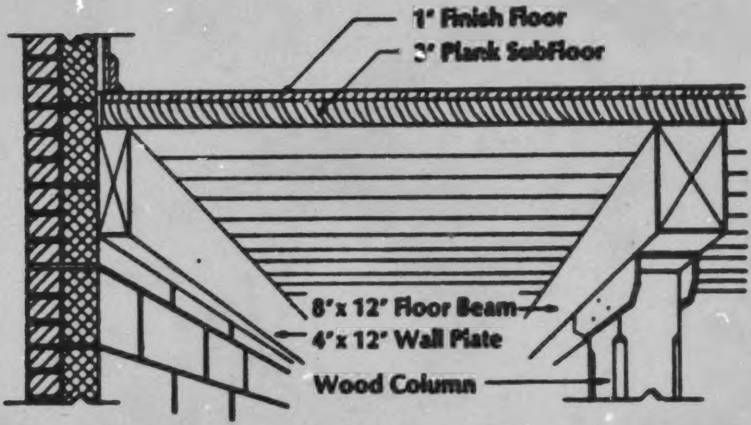
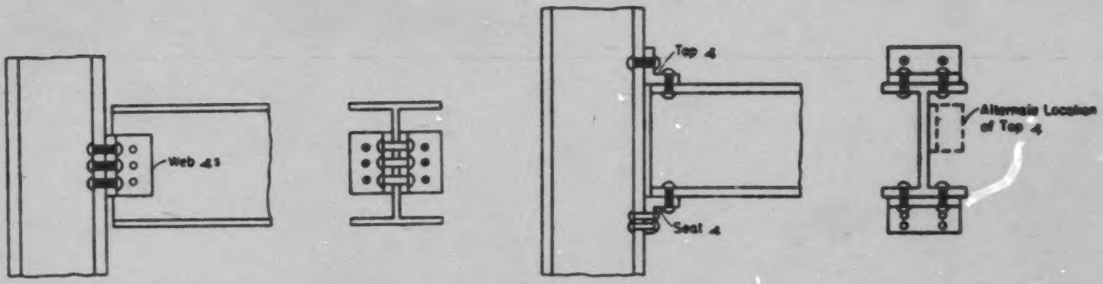

STEEL FRAME CONSTRUCTION
FEED-WAY HEADER
CEL-WAY DUAL CELL
FACTORY INSTALLED DUAL INSERT
FEED-WAY ACCESS HATCH
COFAR COMPOSITE FLOOR DECK
CUTAWAY SECTION

Figure A.20


1" Finish Floor
3" Plank SubFloor
8"x 12" Floor Beam
4"x 12" Wall Plate
Wood Column

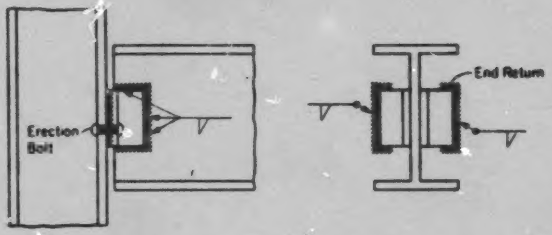
Heavy–Timber or Mill Construction

Figure A.21

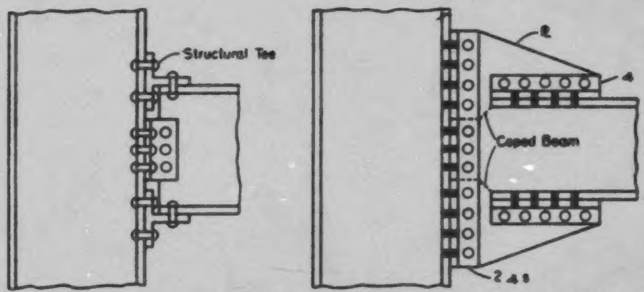

Web ∠s
Top ∠
Seat ∠
Alternate Location of Top ∠

(a) Framed simple connection (bolted or riveted)

(b) Seated simple connection (bolted or riveted)

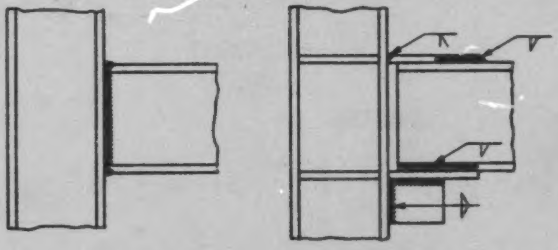

Erection Bolt
End Return

(c) Framed simple connection (welded)


Structural Tee
ℓ
4
Coped Beam
2 ∠s

(a) Structural tee connection

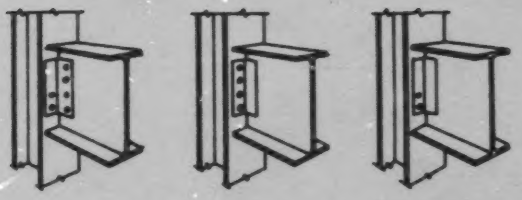
(b) Bracket connection



(c) Welded moment-resisting connection

(d) Welded moment-resisting connection

Figure A.22



(a) (b) (c)

FIELD WELDED FIELD BOLTED FIELD WELDED

SHOP RIVETED OR BOLTED SHOP WELDED

Figure A.23

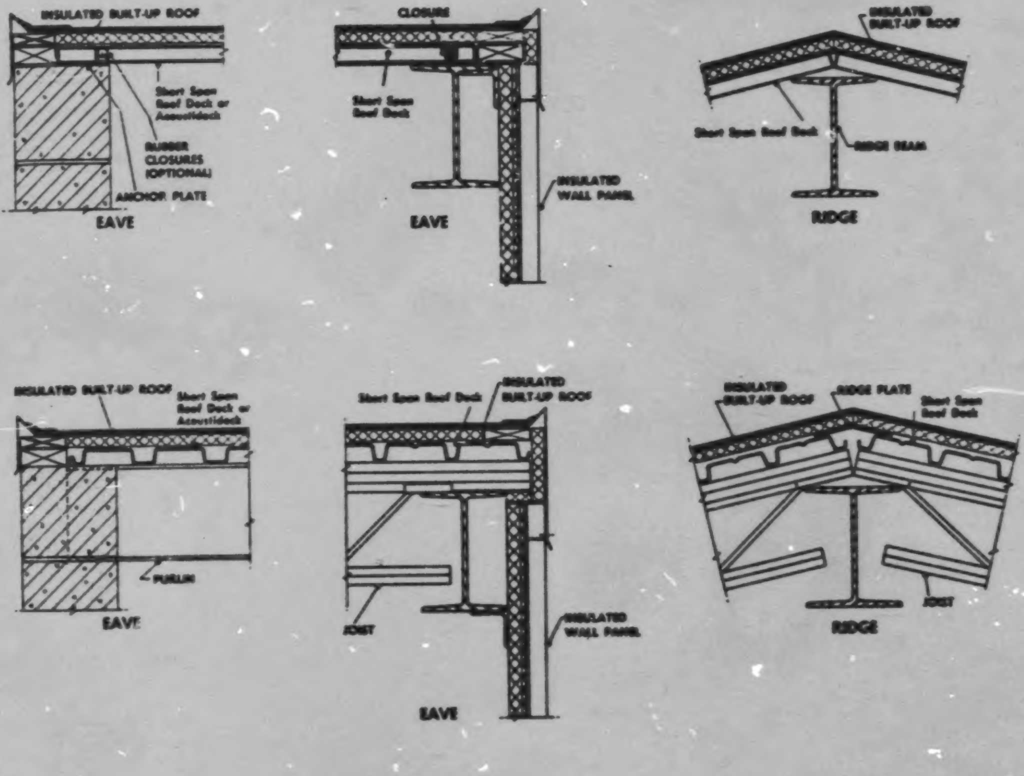

INSULATED BUILT-UP ROOF
Short Span Roof Deck or Acoustideck
RUBBER CLOSURES (OPTIONAL)
ANCHOR PLATE
EAVE
CLOSURE
Short Span Roof Deck
INSULATED WALL PANEL
EAVE
INSULATED BUILT-UP ROOF
Short Span Roof Deck
RIDGE BEAM
RIDGE
INSULATED BUILT-UP ROOF
Short Span Roof Deck or Acoustideck
PURLIN
EAVE
Short Span Roof Deck
INSULATED BUILT-UP ROOF
JOIST
INSULATED WALL PANEL
EAVE
INSULATED BUILT-UP ROOF
RIDGE PLATE
Short Span Roof Deck
JOIST
RIDGE

Figure A.24

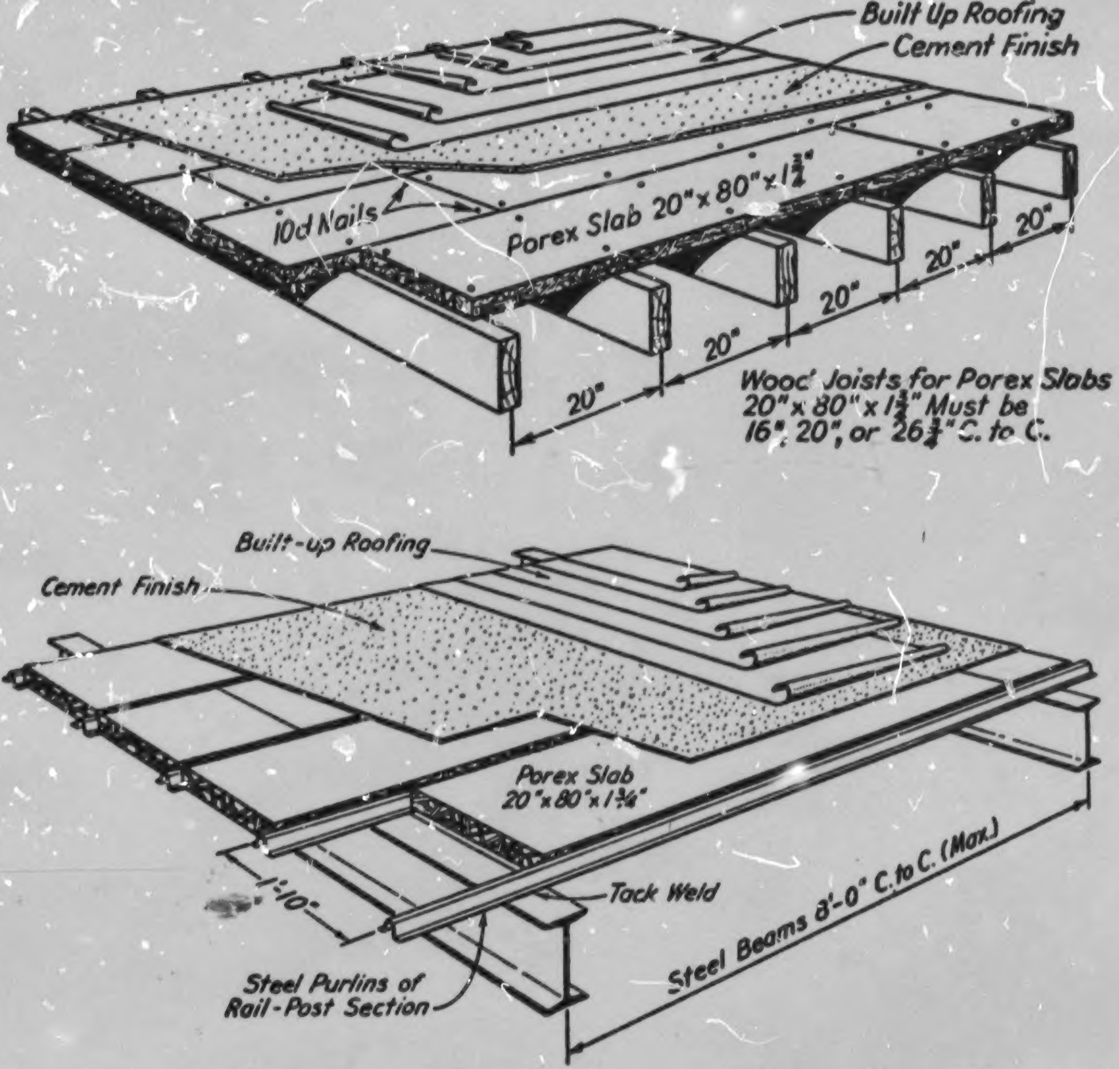
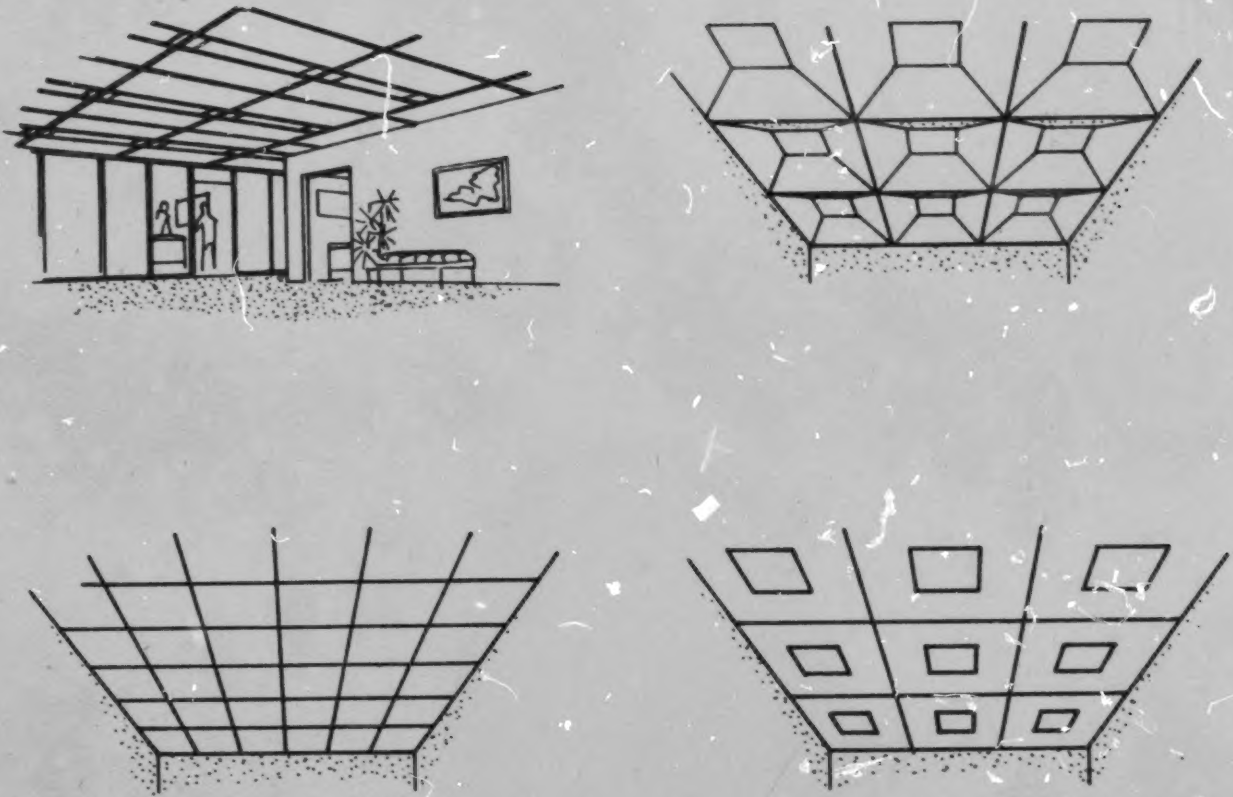

Built Up Roofing
Cement Finish
Porex Slab 20" x 80" x 1¾"
10d Nails
20"
20"
20"
20"
20"
Wood Joists for Porex Slabs 20" x 80" x 1¾" Must be 16", 20", or 26⅔" C. to C.
Built-up Roofing
Cement Finish
Porex Slab 20" x 80" x 1¾"
1'-10"
Tack Weld
Steel Purlins of Rail-Post Section
Steel Beams 8'-0" C. to C. (Max.)

Figure A.25



Typical Appearance of Acoustical Tile Ceilings

Figure A.26

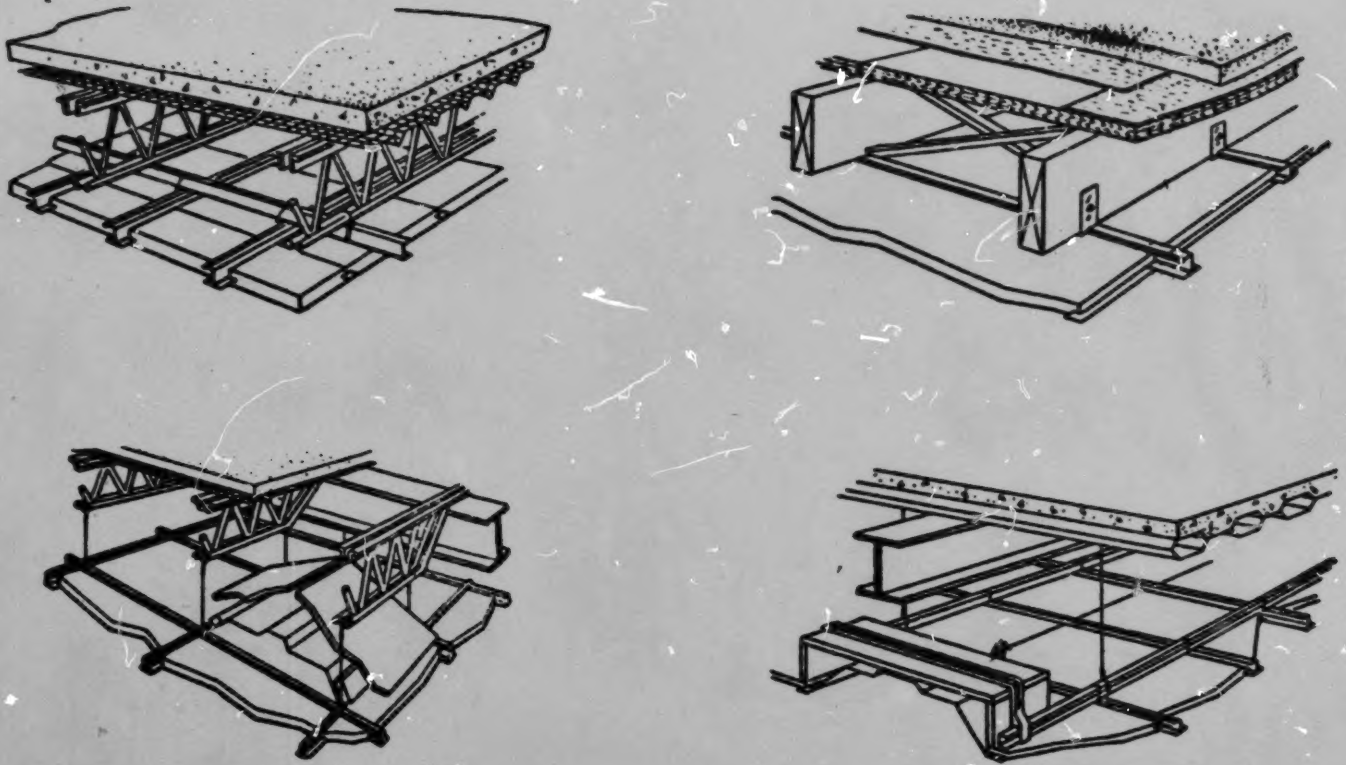
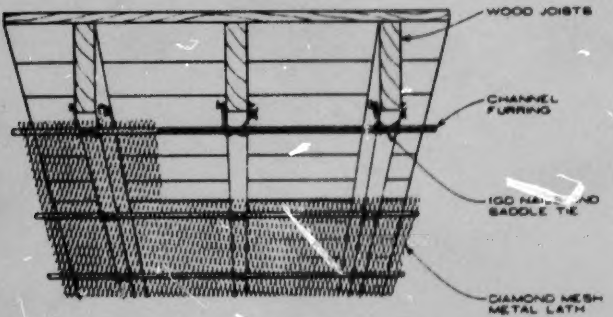
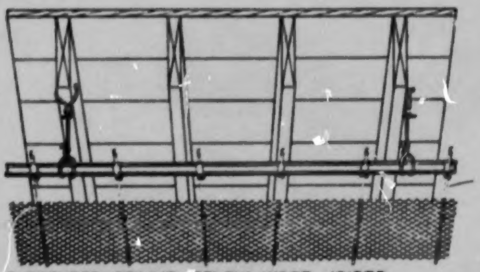


ILLUSTRATION OF DIRECTLY ATTACHED AND SUSPENDED ACOUSTICAL TILE CEILINGS

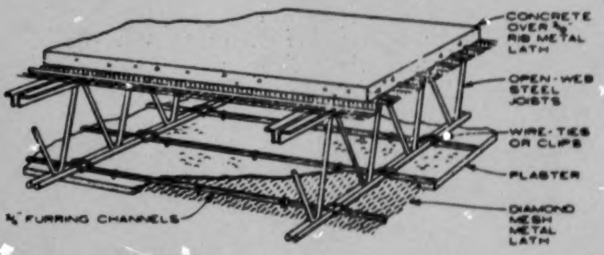
Figure A.27


WOOD JOISTS
CHANNEL FURRING
10D NAILS AND SADDLE TIE
DIAMOND MESH METAL LATH

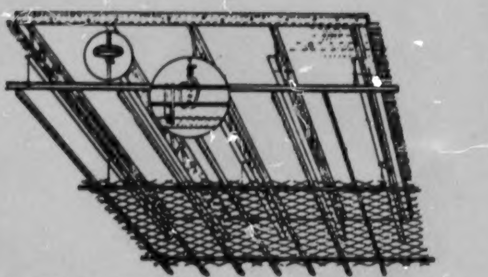
FURRED METAL LATH ON WOOD JOISTS



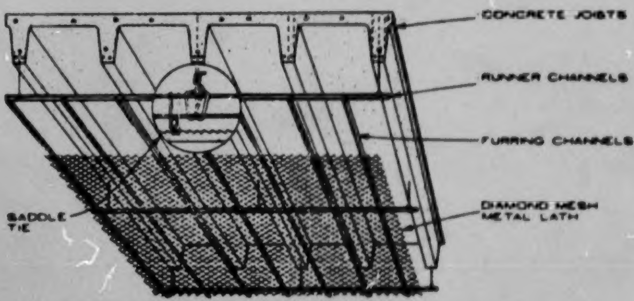
SUSPENDED CEILING BELOW WOOD JOISTS


CONCRETE OVER 3/8" RIB METAL LATH
OPEN-WEB STEEL JOISTS
WIRE-TIES OR CLIPS
PLASTER
DIAMOND MESH METAL LATH
3/4" FURRING CHANNELS

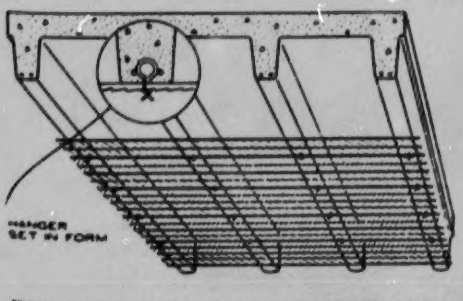
FURRED METAL LATH ON OPEN WEB STEEL JOISTS



SUSPENDED CEILING BELOW OPEN WEB STEEL JOISTS


CONCRETE JOISTS
RUNNER CHANNELS
FURRING CHANNELS
DIAMOND MESH METAL LATH
SADDLE TIE

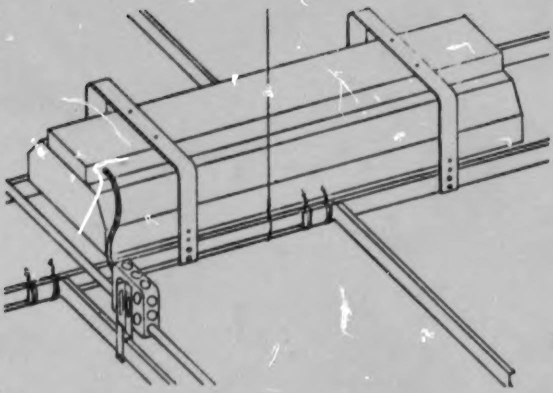
SUSPENDED CEILING BELOW CONCRETE JOISTS


HANGER SET IN FORM

(CONTACT) RIB METAL LATH ON CONCRETE JOISTS

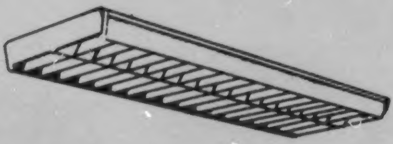
ILLUSTRATION OF DIRECTLY ATTACHED AND SUSPENDED PLASTER CEILINGS

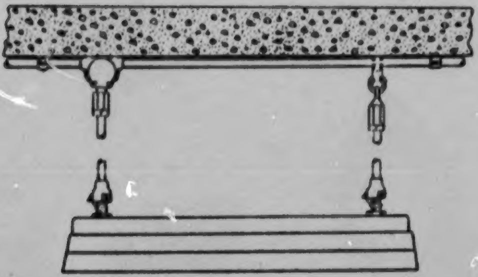
Figure A.28



RECESSED FIXTURE

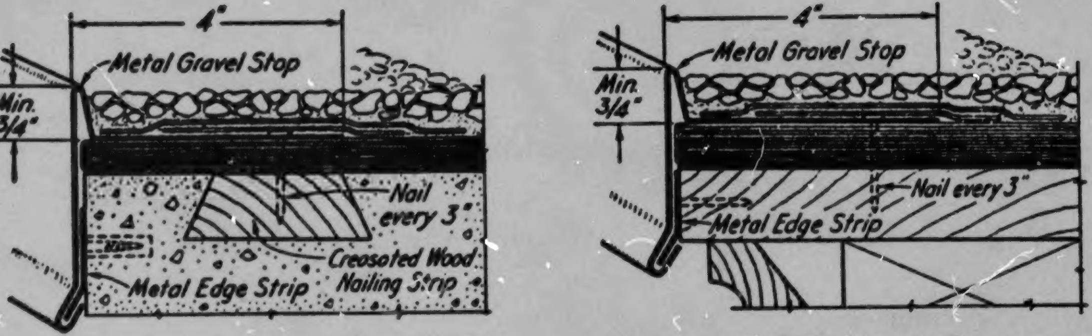
SURFACE MOUNTED FIXTURE





PENDANT FIXTURE

Figure A.29


4"
Metal Gravel Stop
Min. 3/4"
Nail every 3"
Creasoted Wood Nailing Strip
Metal Edge Strip
4"
Metal Gravel Stop
Min. 3/4"
Nail every 3"
Metal Edge Strip

SECTION A-A
METAL EAVE FOR CONCRETE DECK

SECTION A-A
METAL EAVE FOR WOOD DECK

Figure A.30

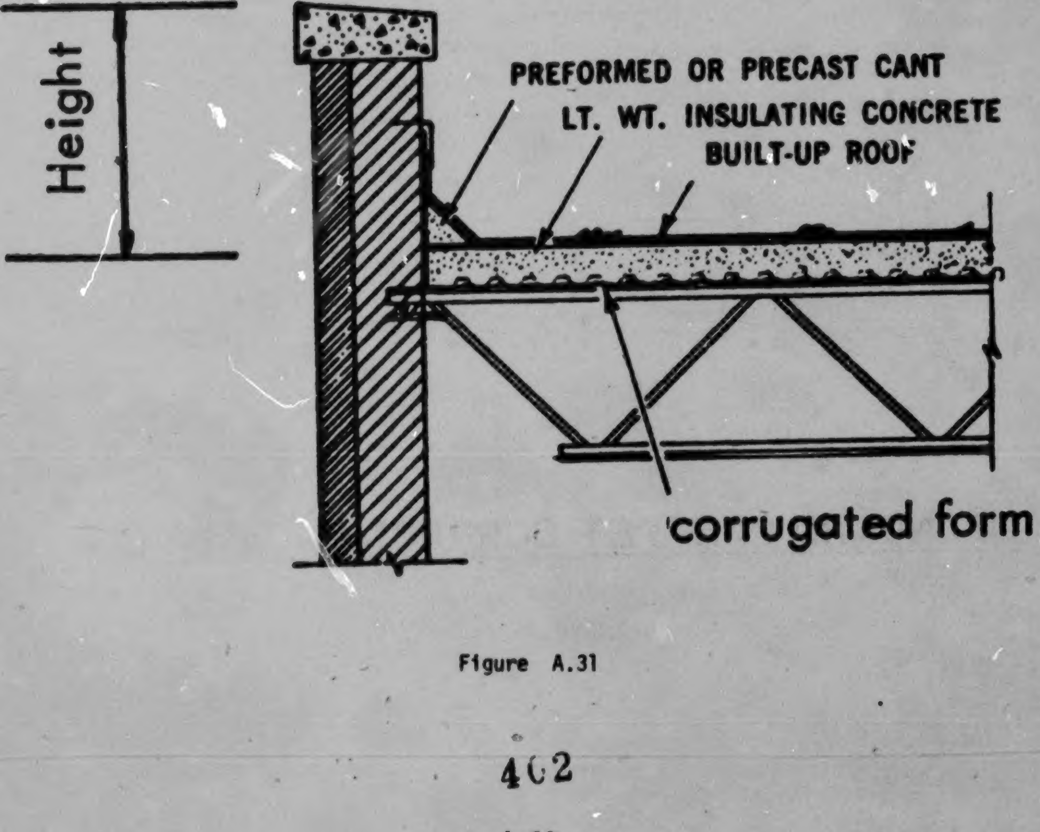
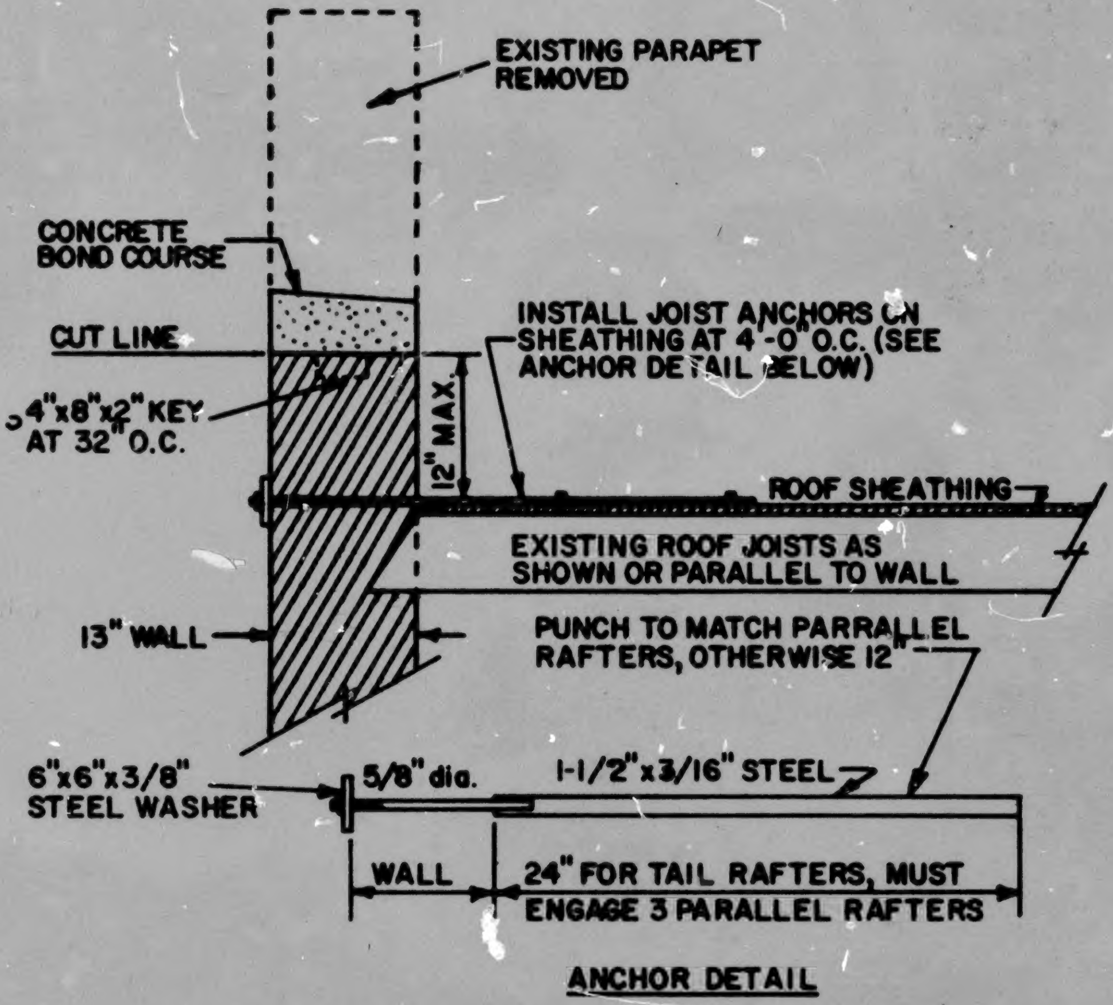

Height
PREFORMED OR PRECAST CANT
LT. WT. INSULATING CONCRETE
BUILT-UP ROOF
corrugated form

Figure A.31


EXISTING PARAPET REMOVED
CONCRETE BOND COURSE
CUT LINE
4"x8"x2" KEY AT 32" O.C.
12" MAX.
INSTALL JOIST ANCHORS ON SHEATHING AT 4'-0" O.C. (SEE ANCHOR DETAIL BELOW)
ROOF SHEATHING
EXISTING ROOF JOISTS AS SHOWN OR PARALLEL TO WALL
13" WALL
PUNCH TO MATCH PARRALLEL RAFTERS, OTHERWISE 12"
6"x6"x3/8" STEEL WASHER
5/8" dia.
1-1/2"x3/16" STEEL
WALL
24" FOR TAIL RAFTERS, MUST ENGAGE 3 PARALLEL RAFTERS
ANCHOR DETAIL

STANDARD PARAPET CORRECTION DETAIL

Figure A.32

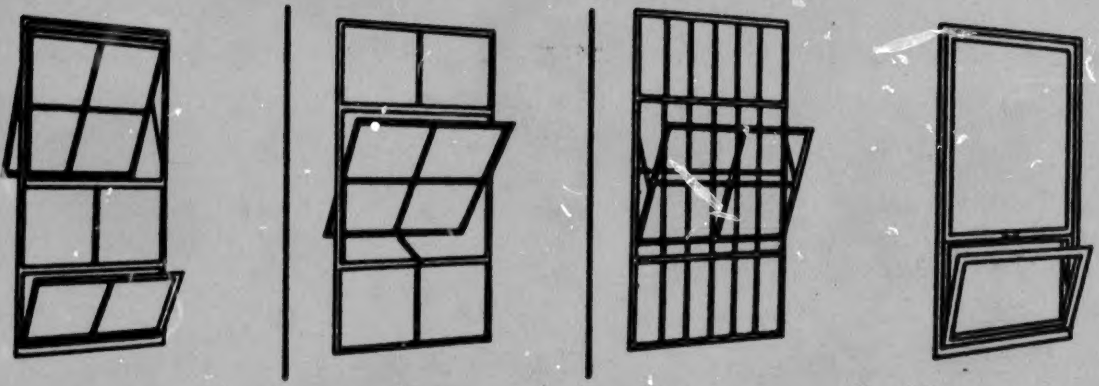


Figure A.33

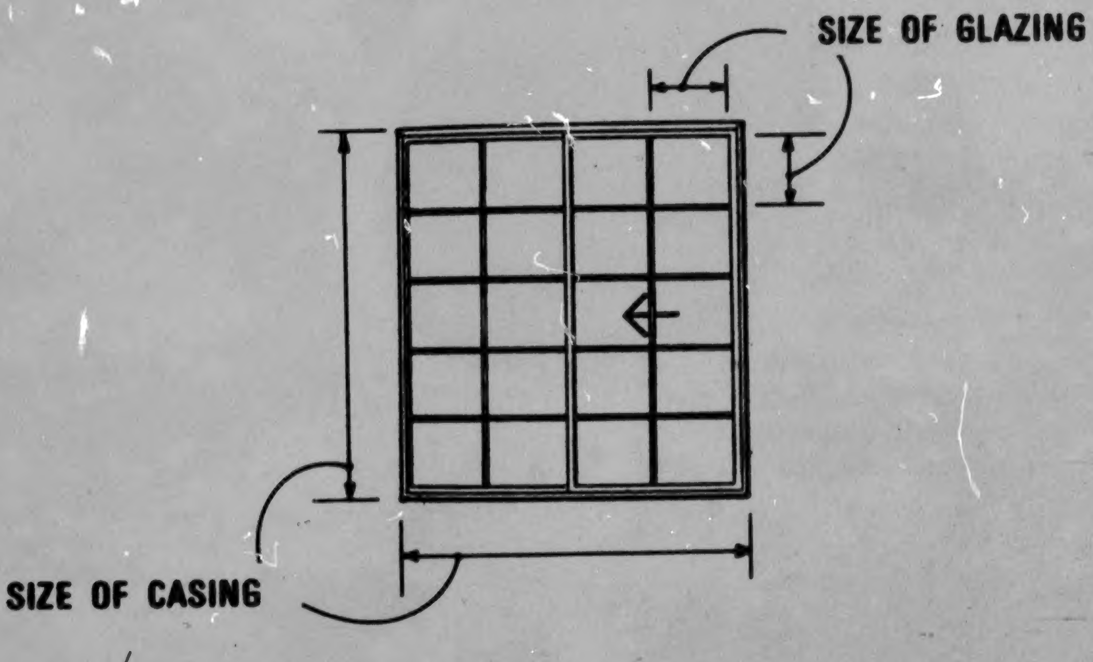

SIZE OF GLAZING
SIZE OF CASING

Figure A.34

APPENDIX B

FIELD EVALUATION METHOD

B.1 PROCEDURE IN EVALUATING BUILDING FOR EARTHQUAKE HAZARD - FIELD EVALUATION METHOD

The Data Collection Form should be checked with the plans if they are available. The seismicity of the site shall be determined by the user. From the information given on the Data Collection Forms or the plans, the "Type" of building can be determined and the "General Rating" selected from the data given on Form FMA-1. The "Symmetry" and "Quantity" of the Vertical Resisting Elements is estimated. A discussion of these items is given in section 3.2. This procedure is followed for both "Transverse" and "Longitudinal" loading. The method of rating these is given on Form FMA-1 and a "Symmetry Quantity Rating (SQR)" is determined. The DC Form is checked to see if any of these elements are damaged and an estimate of the degree of damage is made. It may be desirable to revisit the site to check on this damage or refer to pictures. This is necessary to give the "Present Condition: rating. Finally, the "Sub-Rating (SR1)" is obtained as shown on Form FM-1.

The Horizontal Resisting Elements are next investigated for "Rigidity", "Anchorage and Connections" and "Chords" are rated for their presence or non-presence. Then a "Sub-Rating" is obtained as shown on Form FMA-2.

Finally, "Sub-Ratings (SR1) and (SR2) as well as the "General Rating" are used to establish the "Basic Structural Rating" and the "Capacity Rating." The method of doing this is described on Form FME. The "Capacity Ratio" then gives a measure of the ability of the building to resist an earthquake at the site.

Exit corridors and stair enclosure walls are rated for general safety on Form FMB-1. The various types of walls and their anchorages are given relative ratings.

Other Life Hazards such as Partitions Other Than on Corridors or Stair Enclosures, Glass Breakage, Ceilings, Light Fixtures, and Exterior Appendages and Wall Cladding are rated as shown on Form FMB-2. If the building has an earthquake gas connection, this is also noted on Form FMB-2.

B.2 PROCEDURE IN EVALUATING BUILDING FOR WIND HAZARD - FIELD EVALUATION METHOD

The Data Collection Form should be checked with the plans if they are available. The type of exposure and the height of the building is taken from the DC Forms and put on Form FMC-1. The basic wind speed for the site must be determined by the user. With these data the tables in ANSI A58.1-72 [3.2] are used to determine the effective velocity pressure and the design unit pressures for positive and negative pressures determined for use in rating the building as a whole.

Sub-Ratings SR1 and SR2 for vertical and horizontal resisting elements are obtained as described in section B.1 and Forms FMA-1 and FMA-2. The "General Rating" is selected from the data given on Form FMA-1. The "Basic Structural Rating" is then determined by the formula given on Form FME.

The "Uplift Anchorage Factors" rating is taken from the information given on Form FMC-1 and the "Corrected Structural Rating" is selected. With the "Corrected Structural Rating," the "Effective Unit Velocity Pressure Capacity" is obtained from the bottom of the form.

The "Capacity Ratio" which is the ratio of the anticipated wind pressure to the pressure which the building can withstand is then computed and entered on Form FME.

The evaluation of Other Life Hazards such as Glass Breakage, Window Frame Anchorage, Roof Panel Anchorage, Wall Panel Anchorage, and Anchorage of Exterior Appendages is given from information obtained from the DC Form or the plans, if they are available. Without calculations, these can only be approximate ratings. These ratings are noted on Form FMC-2.

The presence of potential wind blown missiles is noted, along with "Type," "Location" and "Distance" from the structure in the table at the bottom of Form FMC-2.

B.3 PROCEDURE IN EVALUATING BUILDING FOR TORNADO HAZARD - FIELD EVALUATION METHOD

The procedure for evaluating a building for tornado hazard is similar to that described for wind except that a so-called "Moderate Tornado" is used as a standard with arbitrarily assumed positive and negative pressures.

The "Basic Structural Rating" is obtained from Form FME as for wind. "Uplift Anchorage Factors" and a "Corrected Structural Rating" are determined as for wind. From this "Effective Unit Velocity Pressure" is obtained as for wind. The ratings are then assigned as given on Form FMD. One other item is used in the rating. If this building is a "Vault-Type" structure as described in section 3.2, it is given a "Good" rating.

The hazards from wind blown debris, both from the building being analyzed and from outside the building, are described as to "Type" and "Location" from information given on the DC Form. The ratings for these hazards is obtained from Form FMD.

Information relative to the suitability and capacity of a basement to serve as a storm shelter is placed in the lower table on Form FMD.

B.4 INSTRUCTIONS FOR USE OF FIELD EVALUATION METHOD RATING FORMS

FORM FMA - 1 - STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

Form FMA - 1 evaluates the vertical resisting elements. In filling out Form FMA-1, in the column headed "Type," the letter designating the type of construction should be placed in the first column. The number indicating the "General Rating" (GR) should also be placed in the form with the earthquake general rating in the column indicated by the symbol "E" and the wind general rating placed in the column designated with the symbol "W." This applies to both transverse and longitudinal loadings.

The next two columns are for "Symmetry" (S) and "Quantity" (Q). Section 3.2 discusses the basis for evaluation of these categories.

The next column is for the "Symmetry-Quantity Rating" (SQR) which is $\frac{S + Q}{2}$.

Thus if $S = 3$ and $Q = 2$, this rating will be $\frac{3 + 2}{2} = 2.5$.

The appropriate rating for "Present Condition" is selected based on the categories listed on the form.

"Sub-Rating" (SR1) is the weighted average in which the "Present Condition" (PC) is given 2 times the value of the "Symmetry-Quantity Rating" (SQR). Thus $SR1 = \frac{SQR + 2PC}{3}$.

FORM FMA - 2 - STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

Form FMA-2 evaluates the horizontal resisting elements. Both roof and floors are evaluated. Section 3.2 discusses floor and roof systems and this form provides for the development of a rating.

In the "Type" column, insert either "A" for Diaphragm or "B" for Steel Horizontal Bracing. Under "Rigidity" (R) place the appropriate rating number from the categories listed.

The ratings for "Anchorage and Connections" and "Chords" are selected from the data given below the table.

"Sub-Rating (SR2)" for both floors and roof is the highest number under "Rigidity," "Anchorage" or "Chords."

FORM FMB-1 - EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE:

The necessary information for filling out this form will be obtained in the field and be available from the Data Collection Form (DC) or may be obtained from the plans. If the information for "Reinforcement" or "Anchorage" is not available, the column entitled "Not Known" should be checked.

"Wall Rating" is determined as follows:

- Where the enclosure walls are of reinforced, cast-in-place concrete or reinforced masonry, and the floors or roof are cast-in-place concrete, it is very probable that such walls will be well-anchored and be a good risk. In such cases an "A" rating will be given.
- Where walls are of unreinforced masonry, unless special anchorage devices are found, a "C" rating will be given.
- Metal stud and plaster walls, or metal studs and drywall walls, if anchored, will be given an "A" rating. Tilt-up concrete walls or pre-cast concrete walls are usually reinforced. They are usually provided with some anchorage but this may or may not be adequate, and the anchorage is usually not visible. If plans show a substantial type of anchorage, an "A" rating should be given. If the anchorage is unknown, an "X" rating should be given. If it is obvious that there is no positive anchorage to the floor or roof above, a "C" rating should be given.
- Wood stud and plaster walls are usually nailed to wood floors and since they are light should be given an "A" rating if attached directly to floors or roof. If free-standing and only attached at the bottom by nails or drive-in fasteners, a "C" rating should be given.
- Hollow tile walls are rarely reinforced and are usually only anchored by a mortar joint. Unless there is positive evidence of special anchorage or of wall reinforcement, the rating will be "C."

The letter ratings are used here rather than numerical ratings because of the generalized nature of the data available from the DC Forms and because mathematical analysis of these exit corridor and stair enclosure walls is not contemplated by the Field Evaluation Method. This is true also for the ratings on Form FMB-2.

FORM FMB-2 - OTHER LIFE HAZARDS - EARTHQUAKE:

Glass Breakage. This hazard usually will be evaluated only on street fronts or adjacent to public ways unless other special locations are deemed to have a high hazard to life. Where the upper levels of a building are set back adjacent to a street front, and if the set back wall has windows whose height above the low roof of the setback is greater than the roof width, such window glass will be considered on a street front. If the glazing requirements of table 3.1 are complied with, the rating given will be "A." If there is very little or no compliance, a "C" rating will be given. Degree of compliance in between these two will be given a rating of "B." If it is not possible to determine the degree of compliance, then an "X" rating should be given. See figure 3.5 where some typical details are given showing how provisions for drift may be made. Earthquake forces normal to the plane of glass are relatively minor because such forces are proportioned to the weight of the glass.

Exterior Appendages and Wall Cladding. The anchorage of exterior appendages and wall cladding elements will probably not be visible unless such an element has fallen off and left the anchorage exposed. If this is noted on the elevations on the DC Form, the remaining anchorage should be checked for corrosion if possible and if corrosion is found, anchorage of other similar elements is suspect. In most cases, however, the anchorage must be determined from plans and specifications. The adequacy of anchorage can be accurately determined only through calculations. This is beyond the scope of the Field Evaluation Method. However, with the exercise of some judgment and "feel," a very approximate hazard rating can be given. The probable types of anchorage for exterior appendages and wall cladding is shown on table 3.2 with appropriate rating recommendations.

Ceilings. For the Field Evaluation Method, the ceiling hazard will be determined by visual observation or perusal of plans and specifications. The items to be determined are whether there is wire X-bracing in the ceiling space, whether the suspended ceiling structural elements (tee-bars or channels) are well-connected to exterior walls or structural members, and whether the structural elements are connected together so as to form an adequate strut between bracing. The presence of heavy light fixtures supported laterally by this ceiling will be noted and, if possible, a determination made as to whether such heavy light fixtures are independently supported. An approximate rating system is suggested as follows:

- Suspended ceilings with good anchorage or confinement of structural ceiling elements to structure of building and good continuity of elements .... A
- Suspended ceilings with frequent wire cross-bracing, both directions .... A
- Incomplete bracing but good continuity .... B
- Suspended ceilings without either X-bracing or adequate connections to walls C
- Suspended ceilings with heavy light fixtures supported vertically or laterally by the ceiling C

Light Fixtures. If access to attic space is available it may be possible to view the support systems for heavy light fixtures. If swivel joints and restraining devices are found, it is probable that the fixture will respond satisfactorily in most earthquake shocks. If not, the fixture supports may break loose and drop. Heavy fixtures supported by the ceiling system itself are covered under the ceiling rating. For the Field Evaluation Method, it is suggested that if no swivel joints or restraining devices are found, unless independently braced, a rating of "C" be given. If they are found, the "A" rating is suggested. No "B" rating is used for this item. If obvious looseness of vertical support connections are noticed, give a "C" rating. The rating should be "A" if no heavy light fixtures are found. An "X" rating should be given if the fixture connection cannot be seen.

Earthquake Gas Connection. Note the presence or non-presence of an earthquake gas connection. If this cannot be determined, check "Not Known."

FORM FMC - 1 STRUCTURAL SYSTEM - WIND RATING

In filling out the rating form, FMC-1, the "Basic Wind Speed" will be that assigned to the area based on information in ANSI A58.1-72. "Exposure" ("A," "B," or "C") is determined from the information on Form DC-7.

When the "Exposure" and "Height" have been determined, go to table 5 of ANSI (there is a table 5 for each of the three exposures) and select the "Effective Velocity Pressure." Multiply by 1.3 or 1.4 (for consideration of the effect of both windward and leeward pressure on the building as a whole) to arrive at the "Design Unit Pressure." "Basic Structural Rating" is taken from Form FME.

The "Uplift Anchorage Factors" are determined from the data on the DC Form and the information given on FMC-1. The "Corrected Structural Rating" is simply the highest numerical rating of either the "Foundation Anchorage," the "Roof Anchorage" or the "Basic Structural Rating."

Go to the bottom of the form and select the "Effective Unit Velocity Pressure Capacity - P_C." Now compute the "Capacity Ratio" with the formula P/P_C. Obviously if P/P_C is greater than 1, the risk is greater; if less than 1, the risk is less. The maximum P_C given on this form is 45. Some buildings, because of height or exposure, may be subjected to much higher pressures "P." Important buildings with a "Capacity Ratio" of 1 or greater should be reviewed by Analytical Methods when P_C is over 45.

FORM FMC-2 - OTHER LIFE HAZARDS - WIND RATING

The important items involved are the strength and size of glass panels, their frame and glazing attachments, and the anchorage of roof panels and of light exterior wall panels and appendages. The rating of some of these may not be determinable by visual inspection. If plans and specifications are available they may show details of glazing and other pertinent anchorages. Proximity to potential wind-born missiles may or may not be obvious, but if a structure were to be located adjacent to an unenclosed lumber yard or similar source of airborne debris, it should be noted. Space is provided on the DC Form for this. With such limitations the Life Hazard rating must be very approximate. Even where anchorages or attachments are present, it would require detailed calculations to fully check them for adequacy.

Glass breakage from forces normal to the plane of glass is more of a hazard in wind than in earthquake. Here the strength of the glass and its thickness and span are the important factors. This is difficult to determine in the field. However, where size of glass panes and thickness of glass can be determined, these items can be compared with the requirements shown on table 3.1. If these comply, the rating should be "A;" if there is medium or partial compliance, the rating should be "B;" if there is little or no compliance the rating is "C;" if unknown, the rating is "X."

Window frame anchorage is important on tall, flexible buildings. Buildings with moment-resistant frames and light exterior curtain walls over 3 stories high and buildings with exterior concrete or masonry walls over 8 stories high fall into this category. In these instances the wind forces parallel to the plane of glass are important and details providing for drift similar to those shown on figure 3.5 should be provided. If drift details have been provided, the rating should be "A;" if not, the rating should be "C." There is no provision for a "B" rating on this item.

The anchorage of roof panels, light wall panels, and exterior appendages is also important. Where the anchorage can be determined, the best judgment must be exercised since detailed computations are not available in the Field Evaluation Method. If what appears to be good anchorage is confirmed, the rating should be "A;" if the anchorage is known to be poor or is obviously missing, the rating should be "C;" if the anchorage is confirmed but appears to be somewhat inadequate or questionable, the rating will be "B;" if the anchorage is unknown, the rating is "X."

In filling out the rating form, the best judgment should be exercized. Place rating terms ("A," "B," "C," and "X") in the appropriate squares.

Under "Potential Missiles from Outside of Structure," note the type of material, the "Quantity" (large or small), and the distance.

FORM FMD TORNADO RATING

The purpose of the FMD Form is to rate the facility as to its exposure and resistance to tornado hazards. The probability of tornado occurrence to the particular area will be provided. The tornado funnels usually move laterally fairly rapidly so that the time of full exposure of any one structure is of comparatively short duration.

The "Effective Unit Velocity Pressure Capacity P_c" may be taken directly from Form FMC-1 if the building has been rated for wind; if not, evaluate as for Wind Rating.

The DC Form have information which will determine whether or not the building will qualify as a vault-type structure. The definition of such a structure is given in section 3.2. If it does so qualify, check the "Yes" box; if not, the "No" box. The "Building-As-A-Whole" is then rated from information in previous columns of the table and the ratings given below the table. For example if P_c = 40 or over, the rating "Fair" is given.

In the table entitled "Hazard from Wind-Blown Debris," the "Location" and "Type" columns are filled out from material given in the DC Forms. The location and type of potential debris inside the building is placed in the columns opposite "Wall Cladding, Appendages, or Glass;" location and type of potential debris outside the building is placed opposite "Other Potential Debris Not Part of the Building." The hazard is then rated. If there is no potential wind blown debris present, the rating "Good" is given; if there is a small amount of potential debris, the rating will be "Fair;" if there is a large quantity, the rating will be "Poor."

The table "Basement Storm Shelter Availability" is primarily informative. Note the presence or non-presence of such a basement. If present, the effective area of the basement should be obtained from the DC Forms and "Capacity" computed on the net effective area based on 15 sq. ft. per person. The building may be either "Suitable" or "Unsuitable" from criteria given in section 3.2.

FORM FME CAPACITY RATIOS - EARTHQUAKE AND WIND RATING

Form FME gives the "Capacity Ratio" to be used in evaluating the ability of the structure to respond to anticipated winds or earthquakes. The "General Rating," taken from Form FMA-1, is placed in the first column. "Sub-Rating SR1" is also taken from Form FMA-1 and is the larger of either the "Transverse Loading" or the "Longitudinal Loading." "Sub-Rating SR2" is taken from Form FMA-2. If the "Sub-Rating (SR2) for "Roof" and "Floors" are not the same, use the larger of the two ratings. Compute the "Basic Structural Rating" using the formula shown below the table. This rating system is intended to provide relative resistive capacities of the buildings evaluated. Without analytical review such ratings can only be approximated.

Capacity Ratio. For Earthquake, the relationship of the "Basic Structural Rating" to ground intensity as given by Modified Mercalli Scale as described by the Seismic Capacity Ratio = $\frac{\text{Basic Structural Rating}}{\text{Intensity Level at Site}}$ in which an approximate "Intensity Level Factor" is assigned for the pertinent Modified Mercalli Scale. The Modified Mercalli Scale is given on table 3.3. The "Capacity Ratio" is a measure of the capacity of the building to resist an earthquake of the intensity level expected at the individual site. "Capacity Ratio" for Wind is obtained from Form FMC-1.

The "Capacity Ratio Rating" included on Form FME gives an approximate meaning to various "Capacity Ratio" values.

B.5 EVALUATION FORMS FMA TO FME

This section presents the evaluation forms for the Field Evaluation Method.

FORM FMA-1

FACILITY NO. ________________ EXPECTED SITE MODIFIED MERCALLI INTENSITY __________

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

VERTICAL RESISTING ELEMENTS							
Type	General Rating (GR)		Symmetry (S)	Quantity (Q)	Symmetry Quantity Rating (SQR) [1]	Present Condition (PC)	Sub-Rating (SR1) [2]
	E	W					
TRANSVERSE LOADING							
LONGITUDINAL LOADING							

FOOTNOTES:

1. Symmetry-Quantity Rating (SQR) = $\frac{S + Q}{2}$.
2. Sub-rating SR-1 = $\frac{SQR + 2PC}{3}$.

	TYPE	GENERAL RATING (GR) Earthquake	GENERAL RATING (GR) Wind
A	Steel Moment Resistant Frames	1	1
B	Steel Frames - Moment Resistance Capability Unknown	2	2
C	Concrete Moment Resistant Frames	1	1
D	Concrete Frames - Moment Resistance Capability Unknown	2	2
E	Masonry Shear Walls - Unreinforced	4	2 or 3
F	Masonry or Concrete Shear Walls - Reinforced	1	1
G	Combination - Unreinforced Shear Walls and Moment Resistant Frames	2	2
H	Combination - Reinforced Shear Walls and Moment Resistant Frames	1	1
J	Braced Frames	1	1
K	Wood Frame Buildings, Walls Sheathed or Plastered	1 or 2	2 or 3
L	Wood Frame Buildings, Walls Without Wood Sheathing or Plaster	4	4

SYMMETRY (of Resisting Elements)	
1	Symmetrical
2	Fairly Symmetrical
2 or 3	Symmetry Poor
3 or 4	Very Unsymmetrical

NOTE: Add 1 (not to exceed 4) to each rating if a high degree of vertical non-uniformity in stiffness occurs.

QUANTITY (of Resisting Elements)	
1	Many Resisting Elements
2	Medium Amount of Resisting Elements
3	Few Resisting Elements
4	Very Few Resisting Elements

NOTE: If exterior shear walls are at least 75% of building length, this rating will be 1.

PRESENT CONDITION (of Resisting Elements)	
1	No Cracks, No Damage
2	Few Minor Cracks
3	Many Minor Cracks or Damage
4	Major Cracks or Damage.

NOTE: If masonry walls, note quality of mortar - good or poor. If lime mortar is poor, use next higher rating.

FACILITY NO. ______________ **FORM FMA-2**

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

HORIZONTAL RESISTING ELEMENTS						
Type		Rigidity (R)	Anchorage & Connections (A)	Chords (C)		Sub-Rating (SR2)
				Longitudinal	Transverse	
Roof						
Floors						

Note: Sub-rating SR2 = Largest of R, A or C.

Type
A Diaphragm
B Steel Horizontal Bracing

Rigidity - Ratings
1. Rigid
1.5 Semi-rigid
2.0 Semi-flexible
2.5 Flexible

Anchorage and Connections - Ratings
1 Anchorage confirmed - capacity not computed, but probably adequate.
2 Anchorage confirmed - capacity not computed, but probably inadequate.
3 Anchorage unknown.
4 Anchorage absent.

Chords - Ratings
1 Chords confirmed, but capacity not computed.
2 Chords unknown, but probably present.
3 Chords unknown, but probably not present.
4 Chords absent.

FACILITY NO. ____________ FORM FMB-1

FIELD EVALUATION METHOD

EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

TYPE OF WALL	REINFORCEMENT			ANCHORAGE					WALL RATING
	Present	Not Present	Not Known	Mortar Only	Dowels	Screws or Bolts	Other	Not Known	
Brick									
Brick									
Concrete Block									
Concrete Block									
Reinforced Concrete									
Tilt-up or Precast Concrete									
Steel Studs & Plaster									
Wood Studs & Plaster									
Hollow Tile									
Hollow Tile & Plaster									

NOTE: Wall Rating on Basis of A, B, C, and X.

FACILITY NO. ________ _____

FORM FMB-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	RATING
Partitions Other Than on Corridors or Stair Enclosures	
Glass Breakage	
Ceiling	
Light Fixtures	
Exterior Appendages and Wall Cladding*	

Ratings
A = Good
B = Fair
C = Poor
X = Unknown

*A description of some of the ratings for Exterior Appendages and Wall Cladding are:

Description	Rating
Spacing of anchors appears satisfactory	A
Size and embedment of anchors satisfactory	A
Spacing of anchors appears to be too great	B
Size and embedment of anchors appears unsatisfactory	C
Anchorage unknown	X
Anchorage corroded or obviously loose	C
No anchorage	C

EARTHQUAKE GAS CONNECTION		
Present	Not Present	Not Known

FACILITY NO.________________

FIELD EVALUATION METHOD

STRUCTURAL SYSTEM - WIND RATING

BUILDING DESIGNATION:

* Exposure A,B or C	* Basic Wind Speed (V_2)	Building Height	* Effective Velocity Pressure (q_F)	**** Design Unit Pressure $q_F x1.4=P$	** Basic Structural Rating	Uplift Anchorage Factors Foundation / Roof	*** Corrected Structural Rating	Effective Unit Velocity Pressure Capacity P_c	Capacity Ratio $\frac{P}{P_c}$

* See ANSI A58.1-72. q_F in pound per square foot.
** From Structural Systems - Form FME.
*** Use Maximum Anchorage Factor (Foundation or Roof) or the Basic Structural Rating, whichever is greater.
**** q_F x 1.3 = P for buildings with height to length ratio less than 2.5.

ANCHORAGE FACTORS

BUILDING TYPE	UPLIFT ANCHORAGE TO FOUNDATION	FOUNDATION ANCHORAGE FACTOR[1]	UPLIFT ANCHORAGE OF ROOF	ROOF ANCHORAGE FACTOR[1]
Heavy Buildings	Good	1.0	Good	1.0
Heavy Buildings	Poor	1.5	Poor	4.0
Light Buildings	Good	1.0	Good	1.0
Light Buildings	Poor	4.0	Poor	4.0

CORRECTED STRUCTURAL RATING	P_c
1. -	45
1.1 to 1.5	40
1.6 to 2.0	30
2.1 to 3.0	20
3.1 to 3.5	10
3.6 to 4.0	5

[1] Factors should be increased 0.5 (not to exceed 4.0) if the building is primarily un-enclosed.

FACILITY NO. ____________ FORM FMC-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - WIND RATING

TYPE OF RISK	RATING
Glass Breakage	
Window Frame Anchorage	
Roof Panel Anchorage	
Wall Panel Anchorage	
Anchorage of Exterior Appendages	

A = Good; B = Fair; C = Poor; X = Unknown.

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE

TYPE	QUANTITY	DISTANCE

FACILITY NO. ______________

FIELD EVALUATION METHOD

TORNADO RATING

EFFECTIVE UNIT VELOCITY PRESSURE CAPACITY P_c (From FMC-1)	DOES BUILDING QUALIFY AS A VAULT-TYPE STRUCTURE?		TORNADO RATING BUILDING-AS-A-WHOLE
	Yes ☐	No ☐	

BUILDING-AS-A-WHOLE RATINGS

Vault Type Building	- Good
P_c = 40 p.s.f. or over	- Fair
P_c = 20 to 40 p.s.f.	- Poor
P_c = Under 20 p.s.f.	- Very Poor

HAZARD FROM WIND-BLOWN DEBRIS				
	LOCATION	TYPE	NOT PRESENT	RATING
Wall Cladding, Appendages, or Glass				
Other Potential Debris Not Part of The Building				

WIND-BLOWN DEBRIS RATINGS

Not Present	- Good
Small Quantity of Potential Hazard	- Fair
Large Quantity of Potential Hazard	- Poor

BASEMENT STORM SHELTER AVAILABILITY	
Present	Yes ☐ No ☐
Capacity*	
Suitability**	

*Based on 15 sq. ft. per person.

**See section 3.2E.

FACILITY NO ________________

FORM FME

FIELD EVALUATION METHOD

CAPACITY RATIOS - EARTHQUAKE AND WIND RATING

	General Rating (GR)	Sub-Rating		Basic Structural Rating*	Capacity Ratio**
		SR1	SR2		
EARTHQUAKE					
WIND					

*Basic Structural Rating = $\frac{GR + 2\text{ (Largest of SR1 or SR2)}}{3}$.

**Capacity Ratio for wind shall be obtained from Form FMC-1. For earthquake, the ratio is obtained from the Basic Structural Rating divided by the Intensity Level Factor at the site as determined from the table below.

Modified Mercalli Scale	Intensity Level Factor
VIII or Greater	1
VII	2
VI	3
V or Less	4

A description of Modified Mercalli Scale is included on table 3.3.

Capacity Ratio Rating	
Capacity Ratio	Rating (In Terms of Risk)
Less than 1.0	Good
1 through 1.4	Fair
1.5 through 2.0	Poor
Over 2.0	Very Poor

APPENDIX C

APPROXIMATE ANALYTICAL EVALUATION METHOD

C.1 GENERAL PROCEDURES IN EVALUATING BUILDING FOR EARTHQUAKE HAZARD USING THE APPROXIMATE ANALYTICAL EVALUATION METHOD

The plans should be checked with the Data Collection Form to see if they represent the "as built" structure and that any additions and alternations are incorporated in the plans.

The site seismicity, based on anticipated ground motion for the design earthquake or earthquakes, would be obtained by assigning the factor Z_c or calculating the factor Z_s.

The original design calculations may or may not be available. If they are available they may have followed code criteria other than 1973 UBC [2.5], in which case all its provisions may not be incorporated into the building. Procedures in checking where seismic design calculations are available will vary somewhat from procedures where they are not available.

Calculations Available

1. Check seismic zone used (Z_c which is the code zone factor Z).
2. Check type of structure and type of framing to see if proper K values have been used (Table 23-1 of [2.5]).
3. Check whether the structure is highly irregular. Does it have setbacks or highly dissimilar stiffness of vertical resisting elements at various levels. Setbacks are covered in Paragraph (i) and Exception 2 to equation 14-2 [2.5]. These are quoted in section 3.3.
4. Check calculation for "T" and determine if "ZKC" has been properly determined (Equations 14-2, 1403, [2.5]).
5. Check calculations for typical dead loads (W) to assure that no important item has been omitted or a decimal point misplaced. (Note that partition loads are dead loads.)
6. Check if base shear, V, is properly computed and distributed. (Equation 14-1, [2.5]).
7. See is proper distribution of horizontal forces has been made from top to bottom of structure as per equations (14-4) and (14-5) of Chapter 23 of UBC.
8. Check lateral force resisting system and the paths of resistance used to see if the assumptions made are reasonable. Check whether the horizontal diaphragms are capable of distributing lateral forces to the vertical resisting elements. This, of course, should be checked for loads in both directions. If vertical resisting elements are not continuous from upper levels to lower levels, make sure that the diaphragms and struts are capable of redistributing the lateral forces. This is for a general check of the system of lateral resistance used.

9. See if relative rigidities of the vertical elements have been considered and whether torsional effects have been considered. It should be kept in mind that a flexible horizontal diaphragm will not transfer lateral loads to vertical elements in proportion to their relative rigidities. (See section 3.3B for quotations from the Tri-Service Manual [3.1] regarding diaphragm flexibility.) Neither will a flexible horizontal diaphragm distribute torsional forces without excessive deformations.

10. Assuming that the calculations have been consistent with code requirements and that the items above listed have been reasonably considered, check unit stresses in the vertical and horizontal resisting elements for the forces assumed. If not, additional calculations may be required to evaluate items not covered. All the elements need not be checked. For instance, in a shear wall resisting system, the stiffest pier or wall element will usually have the highest unit stresses. Sufficient checks with assistance from eyeball interpolations or extrapolation should be made to ascertain critical elements. In multi-story buildings, the top and bottom stories and, say, at least one intermediate story between should be checked. Where multi-story moment resisting frames are used, the logical check levels would be at the lower story of a column section where changes occur. Steel column sections are usually maintained constant for two or three stories.

11. The overturning calculations should be reviewed to determine if properly carried out and the foundations and soil pressures checked for total compression or net tension adequacy.

12. Drift calculations are not necessary on one or two story buildings with reinforced concrete or masonry shear walls. Tall buildings using moment resistant frames or obviously flexible type buildings should be checked for story to story drift to determine compatibility with nonstructural items but this information will not be needed for structural system evaluation.

13. Determine the critical stress ratio (f_e/f_a) based on the Z_c used in the original calculations. This ratio shall be modified by Z_s/Z_c if the site seismicity is different from that used in the original design. These items are summarized on Form AMA.

Calculations Not Available

Where calculations are not available, it will be necessary to make sufficient calculations to determine the building's resistance capacity.

1. Determine the appropriate seismic zone factor as discussed previously.

2. Proceed as described in "Calculations Available" (starting with Item 2) except that calculations are made instead of checked. Calculations to determine the forces to be applied to the building for a static analysis should be complete. Stress analysis need be only as complete as in the checking analysis previously described in paragraph entitled "Calculations Available." The critical element stresses are determined and the critical stress ratio (f_e/f_a) calculated as in Item 13 above.

Exit Corridor and Stair Enclosure Walls

The failure of brittle masonry walls surrounding exit corridors and stairs may cause loss of life in a severe earthquake. The evaluation of such enclosure walls and their anchorage should be given special attention. The evaluation of these elements will be indicated on Form AMB-1. The forces to be used in analysis are those for the applicable portions of buildings as described below.

Portions of Buildings

Parts or portions of buildings and their anchorage should be analyzed for lateral forces in accordance with the formula $F_p = Z_s C_p W_p$. Table No. 23-J of 1973 UBC [2.5] gives the value for C_p with applicable footnotes. Some of the items involved here are important in that life hazards are involved. Falling parapets or appendages on a public way, for instance, constitute such a hazard and a separate rating form (AMB-2) is provided for noting any non-compliance.

C.2 GENERAL PROCEDURES IN EVALUATING BUILDINGS FOR WIND HAZARD USING THE APPROXIMATE ANALYTICAL EVALUATION METHOD

The plans should be checked with the Data Collection Form to see if they represent the "as built" structure. Proceed as follows:

1. Determine the Basic Wind Speed assigned to the site.
2. Determine the Effective Velocity Pressure (q_p) from table 5 of ANSI [3.2] and the External Pressure Coefficients from table 7.
3. Make a pressure diagram for the building as a whole.
4. If original wind calculations are available, check these pressures obtained from ANSI Tables with the pressures originally calculated.
5. Check the adequacy of the horizontal distribution system (diaphragms) to distribute wind forces to the vertical resisting elements.
6. Check the adequacy of the vertical resisting elements for shear and axial loads. Also check if the center of resistance coincides wity the center of applied wind forces. If there is significant eccentricity in either axis of the building there will be torsion and this should be considered in the check of both horizontal and vertical elements.
7. Determine the Critical Element or Elements and the Critical Stress Ratio. With this the rating of the Building-As-A-Whole is made on Form AME.
8. Using the coefficients given in ANSI 6.5.3.2 [3.2], check for uplift on the roof.
9. Check exposed elements for positive or negative pressures.

10. Check Anchorage of exposed elements, such as Wall Panels, Wall Cladding, and appurtenances such as Canopies.

11. Check the Anchorage of such elements as Window Frames, Wall Cladding and Exterior Appendages and determine the Critical Stress Ratio for these anchors. From this a rating can be placed for these items on Form AMC-2.

12. Check the DC Form for presence and distance of Potential Windblown Debris and note same on Form AMC-2.

13. Check the adequacy of Window Glass and Glazing for the pressures noted and rate these items on Form AMC-2.

C.3 GENERAL PROCEDURE IN EVALUATING BUILDING FOR TORNADO HAZARD USING THE APPROXIMATE ANALYTICAL EVALUATION METHOD

Check the plans with the Data Collection Form to see that the plans represent the "as built" structure. Proceed as follows:

1. Calculate the wind forces on the building as a whole using 80 p.s.f. on the windward side and 60 p.s.f. on the leeward side. Use a suction force on all exposed roofs or horizontal areas of 172 p.s.f. The stresses on various resisting elements produced by these forces is f_T. These stresses (f_T) will be related to a design ultimate capacity of the resisting systems.

   The ultimate capacity of the elements is used for f_a tornado because of the relatively short duration of full tornado forces and the limited area over which these forces would act at any one instant of time. Since the tornado forces assumed are rough estimates, it is felt that the use of ultimate capacities of resisting elements is warranted.

   The stress (f_a) is the capacity of the member in excess of that required to support the gravity loads. f_a at the ultimate capacity of the members shall be based on the values indicated in the following table:

MATERIAL	BASIS FOR STRESS AT ULTIMATE CAPACITY
Concrete	ACI 318-71 [C.1]
Structural Steel	Part 2, AISC 1969 Specifications [C.2]
Light Gauge Steel	1.7 times AISI 1968 Specifications [C.3]
Aluminum	1.7 times 1967 Specifications of The Aluminum Association [C.4]
Masonry[a]	2.0 times UBC 1973 [2.5]
Wood[a,b]	2.5 times UBC 1973 [2.5]

a. Other Code or Specifications containing working stress material capacities may be used.

b. When data is based on the inclusion of the 1/3 increase on working stresses for wind or earthquake loading (such as diaphragms) the multiplier is reduced by (2.5/1.33) = 1.9.

2. Calculate the effect of uplift on exposed roof areas considering the weight of the roof.

3. (a) Check capability of roof and floor systems to transmit lateral forces to vertical resisting elements. This includes anchorage check.

   (b) Calculate the critical stress ratio, f_T/f_a, on critical elements.

4. (a) Check capability of vertical elements such as shear walls or moment resisting frames to deliver forces to the foundations. This includes a check of the anchorage of these elements to foundations.

   (b) Calculate the critical stress ratio, f_T/f_a, on critical elements.

5. (a) Check capability of foundations to resist net forces of sliding, overturning, and suction.

   (b) Calculate the critical stress ratio, f_T/f_a, on critical elements.

6. Note any special cases such as large canopies or roof structures. These should be checked for capacity to withstand these forces.

7. Check strength and anchorage of wall cladding and appendages. If the stress, f_T, is less than f_a, they will be considered adequate. If not, they will be considered inadequate. These are the only ratings.

8. Check strength and anchorage of doors and glazed areas. The same assumptions and ratings as given in Item 7 will apply to glass panes and their frames and attachments, and to doors and their attachments.

The critical stress ratios, f_T/f_a, are approximate indicators of the ability of a building to withstand tornadoes. The real capacity of the element may vary from f_a, but the degree of variation is dependent on the materials considered. Consistency in quality and workmanship, in accuracy in load calculations, and uncertainty in loads influences the reliability of f_T.

Since failure of any of the resisting systems could cause failure of the entire structure, the final building rating is based on the lowest of any of the systems.

Damaged Elements

Where any of the resisting elements are found to be badly cracked, bent, or otherwise severely damaged, they may very well fail under tornado loadings. If such a member is critical to the system it should be field evaluated and its computed capacity arbitrarily reduced by judgment.

Debris

The presence or non-presence of potential wind blown debris in the area outside the facility can be noted on the rating form. If such potential wind blown missiles are observed in the area, the box marked "Present" should be checked; otherwise, check "Not Present." If the "Present" box is checked, a supplemental note describing the material and its general location should be attached to the rating form.

C.4 INSTRUCTIONS FOR THE APPROXIMATE ANALYTICAL EVALUATION METHOD RATING FORMS

FORM AMA-1 - Structural Systems - Earthquake

In the first column, "Type of Frame," enter the applicable letter from the list of types given below.

The second column is headed "Type of Diaphragm." Enter in this column the type of material the diaphragm consists of, such as reinforced concrete, metal deck, wood floor, precast concrete units, etc.

In the column headed "Modified Mercalli Scale Intensity," enter the MMI for the site if explicitly assigned by the user or determined using the concepts of section 3.4. For example. Eqs. (3.4.2) and (3.4.3) relate MMI to a selected earthquake magnitude and hypocentral distance.

In the next column, the "Z_s" factor should be entered as determined from the formula given in the paragraph entitled Site Seismicity for the Approximate Analytical Method in section 3.3. The "Z_c" factor on which the original calculations were based should be entered in the next column. If calculations were for the site "Z_s" factor, enter this also in the "Z_c" column. If no Z_s is determined, enter Z_c in the "Z_s" column.

In the "Critical Elements" column, there are two items. Under "Type," designate the kind of element such as column, beam, girder, truss, or shear wall. Under "Location," give the location such as "1st Floor," "3rd Floor," etc.

In the last column "Critical Stress Ratio," enter the ratio f_e/f_a modified by Z_s/Z_c. This should be done for the various critical elements analyzed so that the greatest f_e/f_a ratio can be readily selected. The greatest critical stress ratio is transferred to Form AME to determine rating for earthquake.

FORM AMB-1 - Exit Corridors and Stair Enclosure Walls - Earthquake:

Most of the types of walls commonly used are listed on this form. More than one type of wall may be used for this purpose in any one building. In the column under "reinforcement," place a check in the appropriate subcolumn as to whether or not reinforcement is present on the type of wall being considered. For wood or steel stud types of walls, leave the "reinforcement" column blank.

Under "Anchorage," place a check in one of the sub-columns opposite the type of wall being considered. If a check is placed in the sub-column labeled "Other," describe this briefly below the table or on a supplementary sheet.

In the "Critical Stress Ratio" column, enter the ratio of stresses in these as determined by analyzing these walls and anchorages for lateral forces, both normal and parallel to the walls.

The "rating" for these exit corridor and stair enclosure walls is taken from the table on Form AME entitled "Rating of Critical Stress "Ratios" and entered in the last column.

FORM AMB-2 - Other Life Hazards - Earthquake:

The critical stress ratio for members and anchorages for the items listed on this form are determined and entered opposite the appropriate types of risk. With these ratios, determine the proper rating from the table on AME entitled "Rating of Critical Stress Ratios" and note this rating in the "Rating" column.

FORM AMC-1 - Structural Systems - Wind:

The rating of the building as a whole is determined by the ratio of the stresses (f_w) resulting from the design pressure to the material design stresses (f_a) - including 33-1/3% increases where permitted. A rating form (AMC-1) has been provided for this. The "Building Designation" is given at the top of sheet. In the first column, list "Exposure A, B, or C" conforming to ANSI designations. In the second column, fill in the "Basic Wind Speed" assigned to the site. This is assumed to be for the 50-year mean recurrence interval. If any other recurrence interval is used, such as the 100-year recurrence interval, it should be noted in parenthesis - (100). In the third column give the height of the building and in the fourth give "Effective Velocity pressure" as determined from table 5 of ANSI [3.2].

In the "Critical Elements" column, list the type and location. The type might be "Column" and the location "1st Story." Or the type might be "large brick pier" with location given as "front wall, second story."

Compute the critical stress ratio and enter it in the column provided.

The "Basic Wind Speed Capacity" is a measure of the capability of the building given as a wind speed at 30 feet above ground. This speed can be used to assess the general capability of the building to resist wind forces but is not used as a rating. The stress-ratio factor "f_w/f_a" gives the relation between the stresses resulting from design pressure and the material design stresses in excess of that required to support gravity loads. Since wind velocity is a function of the square root of the pressure, the "Basic Wind Speed (V_1)" can be proportioned to "Basic Wind Speed Capacity (V_2)" by multiplying V_1 by the square root of f_a/f_w. Thus, if the Basic Wind Speed at the site is 100 m.p.h. at 30 feet height, and the inverted stress ratio factor f_a/f_w is 1.4, the Basic Wind Speed Capacity (V_2) will be 100 x $\sqrt{f_a/f_w}$ = 118 miles per hour. It should be noted that wind pressures at various heights do not vary in a constant proportion. Therefore, this is only an approximate solution.

FORM AMC-2 - Other Life Hazards - Wind:

Glass Breakage

Table 54-A of the Uniform Building Code [2.5] gives the allowable areas of glass in square feet for various wind loads in p.s.f. up to 100 p.s.f., with required thickness of plate or float glass or sheet glass. Select the proper wind pressure (positive or negative) and check for compliance with this table. The ratings for this item are simply "Compliance" or "Non-Compliance" for the various types of glass, including wired glass, as given in table 54-B "Adjustment Factors" of UBC.

Glazing

Glazing requirements are given in table 54-C of UBC for both doors and windows. The ratings for this item will be "Compliance" or "Non-Compliance."

Window Frame Anchorage

The applicable wind pressure is distributed to the anchors and the stress in the anchors determined based on the anchorage pattern. The stress in the anchor produced by the wind is compared with the allowable design stress in the anchor to determine the critical stress ratio.

Wall Cladding Anchorage

The applicable wind pressure on the cladding is determined. The wind force (positive or negative) assigned to the anchors can then be computed, considering their spacing and location. Except for extremely light wall claddings, such as 16 gage sheet metal or under, the vertical loads on the anchors should also be considered in the computations. The stresses so computed in the anchors or in the material to which the anchors are connected are then compared with the allowable design stresses to obtain the critical stress ratio.

Anchorage of Exterior Appendages

The anchorage of exterior appendages can be computed and rated as described for "Wall Cladding Ancnorages."

Exposed Walls

The maximum wind pressure, either positive or negative, applied normal to the wall, is used for the appropriate heights above ground. Such walls are checked as vertical slabs and may be considered as one-way slabs or two-way slabs with or without continuity as the situation may warrant. The stress ratio is then computed. The rating is obtained from the table at the bottom of Form AMC-2.

The walls at corners of the building for a horizontal width equal to 1/10 of the least width of the building should be checked for a suction equal to twice the effective velocity pressure in a similar manner.

These ratings are entered in the appropriate boxes.

Canopies and Eaves

Where these occur, they will be checked for an uplift force of 0.7 times the effective velocity pressure and the critical stress ratio computed. From this, the rating is obtained from the lower table and entered in the appropriate box. The dead load of canopies and eaves should be subtracted from the uplift force.

Potential Missiles from Outside of Structure

This item is noted but not rated. See section 3.2D on potential wind blown missiles in the Field Evaluation Method. This is based on field observations only. Under "Type", note the type of material in the adjacent area that might be wind blown. Under "Quantity", note "large" or "small. Under "Distance", note the approximate distance of the potential missile material from the structure being evaluated.

FORMS AMD-1 AND AMD-2 - Tornadoes:

Reference is made to section C.3 "General Procedure in Evaluating Building for Tornado Hazard." The Critical Stress Ratios "f_T/f_a" are determined as described therein. These ratios are then placed in the appropriate spaces after each of the "Systems" listed. The highest critical stress ratio of any of these Systems is used to fill in the space after "Tornado" in the upper table on Form AME. The Tornado Ratings for various Critical Stress Ratios are given in the table "Rating of Critical Stress Ratios" on Form AME.

On Form AMD-2, the strength and anchorage of Wall Cladding and Appendages is analyzed as described in section C.3, and the rating "Adequate or Inadequate" entered in the appropriate space. Similarly the strength and anchorage of glazed areas is determined and rated in the adjoining space.

For Exposed Walls use the maximum wind pressures, either positive or negative applied normal to the walls. This is 80 psf on the windward side and 50 or 60 psf on the leeward side depending on the height-to-width ratio of the building (ANSI, 6.3.4.1. [3.2]) Check these walls as vertical slabs as given in the Instructions for Wind and compute the Critical Stress Ratio. The rating is then obtained from the table at the bottom of Form AMD-2 and placed in the appropriate box. No special consideration is given to corner walls.

For Canopies and Eaves, these elements are checked for uplift values of 172 p.s.f. as for roofs. Dead loads should be subtracted. The Critical Stress Ratio for these elements is computed and the rating obtained from the table at the bottom of the form. The rating is placed in the proper box.

Potential Missiles from Outside of Structure

The presence or non-presence of potential wind blown debris is taken from the Data Collection Form and noted in the table near the bottom of this form.

FORM AME - Structural Systems Rating Form - Earthquake, Wind, Tornado:

This form relates the Critical Stress Ratios to final ratings for Structural Systems and is for the hazards of earthquake, wind, and tornado. The Critical Stress Ratios for Structural Systems are taken from the applicable Approximate Analytical Method Forms for the hazards being considered and placed in the second column. The "Rating" is then taken from the table below. This table gives different ratings for Tornado than for Earthquake and Wind. In the tornado ratings ("good," "fair," etc.), consideration has been given to the probability of a direct hit by a tornado over the entire structure and to the fact that these extremely high forces are in effect for only a few seconds.

C.5 EVALUATION FORMS AMA TO AME

The following pages contain the above noted forms.

FACILITY NO. ________________ FORM AMA-1

APPROXIMATE ANALYTICAL METHOD
STRUCTURAL SYSTEMS - EARTHQUAKE RATING

BUILDING DESIGNATION:							
Type of Frame	Type of Diaphragm	Modified Mercalli Intensity	Z_s	Z_c	Critical Elements		Critical Stress Ratio (f_e/f_a)
					Type	Location	

TYPE

A Steel Moment Resistant Frames
B Steel Frames - Vertical Load Carrying Only
C Concrete Moment Resistant Frames
D Concrete Frames - Vertical Load Carrying Only
E Masonry Shear Walls - Unreinforced
F Masonry or Concrete Shear Walls - Reinforced
G Combination - Unreinforced Shear Walls and Moments Resistant Frames
H Combination - Reinforced Shear Walls and Moment Resistant Frames
J Braced Frames
K Wood Frame Buildings, Walls Sheathed or Plastered
L Wood Frame Buildings, Walls Without Wood Sheathing or Plaster
M Other

Z_s = Zone factor determined for site from Modified Mercalli Intensity.

Z_c = Zone factor from Code.

NOTE: For rating of Structural Systems, use Form AME.

FORM AMB-1

FACILITY NO. __________________

APPROXIMATE ANALYTICAL METHOD
EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

Type of Wall	Reinforcement		Anchorage				Critical Stress Ratio f_e/f_a	Rating*
	Present	Not Present	Mortar Only	Dowels	Screws or Bolts	Other		
Brick								
Brick								
Concrete Block								
Concrete Block								
Reinforced Concrete								
Tilt-up or Precast Concrete								
Steel Studs & Plaster								
Wood Studs & Plaster								
Hollow Tile								
Hollow Tile & Plaster								

*Obtained from Form AME - Rating of Critical Stress Ratios.

FORM AMB-1

FACILITY NO. ________________ FORM AMB-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING*
Partitions Other Than on Corridors or Stair Enclosures		
Exterior Appendages and Wall Cladding		
Ceiling		
Light Fixtures		

*See Form AME - Rating of Critical Stress Ratios.

FACILITY NO. ____________

APPROXIMATE ANALYTICAL METHOD
STRUCTURAL SYSTEMS - WIND RATING

BUILDING DESIGNATION:

Exposure A,B,or C	Basic Wind Speed* V_1	Building Height	Effective Velocity Pressure q_F	Design Unit Pressure $q_F \times 1.4 = P$ or $q_F \times 1.3 = P$	Critical Elements		Critical Stress Ratio f_w/f_a	Basic Wind Speed Capacity $V_2 = V_1\sqrt{f_a/f_w}$
					Type	Location		

*See ANSI A58.1-72

f_w = Stress resulting from design pressures.

f_a = Allowable Material stress (x 1.33 where applicable)

NOTE: For rating of Structural Systems, use Form AME.

FACILITY NO. ______________ FORM AMC-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - WIND RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING
Glass Breakage*	------	
Glazing*	------	
Window Frame Anchorage		
Wall Cladding Anchorage		
Anchorage of Exterior Appendages		
Exposed Walls		
Canopies and Eaves		

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE*

TYPE	QUANTITY	DISTANCE

*See Instructions for ratings.

CRITICAL STRESS RATIO	RATING
< 1.0	Good
1.0 to 1.5	Fair
> 1.5	Poor

FACILITY NO. ________________ FORM AMD-1

APPROXIMATE ANALYTICAL METHOD
RATING FORM - TORNADOES

SYSTEMS CRITICAL STRESS RATIOS*

SYSTEM	f_T/f_a **
Roof	
Roof Anchorage	
Floor	
Floor Anchorage	
Vertical Resisting Element	
Anchorage to Footings	
Footings	

*Use highest Critical Stress Ratio.
For Structural Systems Rating - Tornado, see Form AME.

**f_T = Capacity required to resist tornado forces.
f_a = Capacity based on design criteria.

FACILITY NO. ________________ FORM AMD-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - TORNADO RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING
Glass Breakage*		
Glazing*		
Window Frame Anchorage		
Wall Cladding Anchorage		
Anchorage of Exterior Appendages		
Exposed Walls		
Canopies & Eaves		

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE*

TYPE	QUANTITY	DISTANCE

*See Instructions for ratings.

CRITICAL STRESS RATIO	RATING
< 2.0	Good
2.0 to 3.0	Fair
> 3.0	Poor

FACILITY NO. ____________ FORM AME

APPROXIMATE ANALYTICAL METHOD
CRITICAL STRESS RATIOS - STRUCTURAL SYSTEMS

	Critical Stress Ratio	Rating
Earthquake		
Wind		
Tornado		

RATING OF CRITICAL STRESS RATIOS

Critical Stress Ratio	Earthquake or Wind	Tornado
Less than 1.0	Good	Good
1 to 1.5	Fair	Good
1.5 to 2.0	Poor	Good
2.0 to 3.0	Very Poor	Fair
3.0 to 4.0	Very Poor	Poor
Over 4.0	Very Poor	Very Poor

APPENDIX D

EXAMPLES

D.1 INTRODUCTION

This appendix presents nine example problems. The examples are intended to familiarize the reader and user with the methods presented in chapter 3. Section D.2 presents a Field Evaluation Method example, sections D.3 and D.4 present solutions using the Approximate Analytical Evaluation Method, and the Detailed Analytical Evaluation Method is applied to several building structures in section D.5 and D.6.

D.2 EXAMPLE 1

A. Preamble

The example selected here is an old two-story building with exterior, unreinforced brick masonry walls, a wood roof and a wood second floor. It is located on a corner with the front and one side facing streets. The rear faces an alley and the other side is on a property line. The front wall has very large glass display windows in the first story and a large glass area in the second story. The side wall facing the street also has large glass areas; the other two walls are nearly solid. The wood roof and floor systems are not properly anchored to provide adequate diaphragms.

The rating forms have been devised to assist in evaluating such factors as mentioned above. Since plans were not available for this building it is rated only by the Field Evaluation Method. It is rated for Earthquake, Wind, and Tornado. Since the Wind rating is rather poor, the rating for Tornado is somewhat unnecessary but this has been included to demonstrate the use of the Field Evaluation Method Forms.

B. Data Collection Form

The Data Collection Form containing Sheets 1-DC-1 to 1-DC-12 has been completed for the building in Example 1 and is included in this section.

/-DC-1

DATA COLLECTION FORM
NATURAL HAZARDS EFFECTS
(Extreme Winds, Earthquakes)

A. GENERAL DATA

*1. Facility No. ______ 2. Building Name EXAMPLE 1

3. Address — 4. City —

5. State — 6. Zip Code — 7. Year Built —

8. Date of Major Modifications or Additions, if any —

9. Building Code Jurisdiction: City ☑ County ☐ State ☐ Federal ☐

*10. Latitude — *11. Longitude —

12. Current Bldg. Use LIGHT MFG. Orig. Bldg. Use UNKNOWN

13. Basement Yes ___ No ✓ Number of Basements ______

No. of Stories Above Basement 2 (See also Item A23)

14. Height of First Story 15 ft.

15. Upper Story Height 11 ft. Special Story Height ______ ft.

16. Is the exterior of first story different from upper stories?

Street Front Side Yes ✓ No ___ Other Sides Yes ✓ No ___

17. Approximate Roof Overhang Distance NONE Side NONE

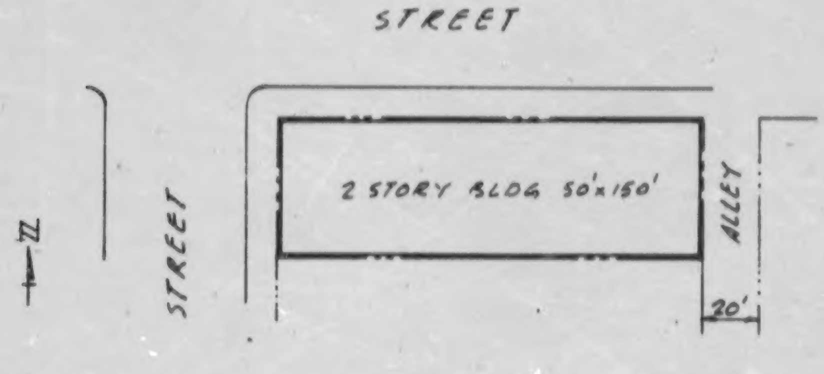
18. Proximity to Adjacent Buildings: Sketch Below with North Arrow

North Side 70' South Side 0 East Side 20' West Side 70'

Note Street or Alley Sides ______

*To be filled in by Field Supervisor.

Sketch



19. Are plans available? NO If so, where obtainable __________ Are original calculations available? NO If so, where obtainable __________

Name of: Architect UNKNOWN Engineer UNKNOWN

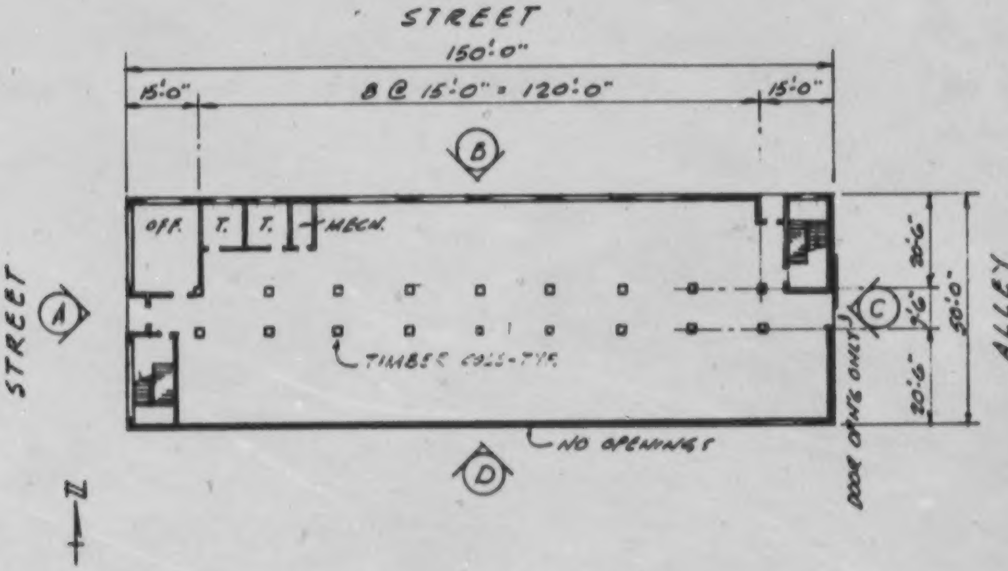
Contractor UNKNOWN

Regulatory Agency CITY

20. Basic Building Plan

a. Sketch overall plan.
b. Locate shear walls, if any.
c. Locate main frames.
d. Locate expansion joints, if any.
e. Give approximate north arrow and label sides "A", "B", "C", "D", etc. Show street or alley sides.
f. Note any common or party walls.
g. If plan changes in upper floors, sketch this plan and note level of change.

(Use additional sheet if necessary)

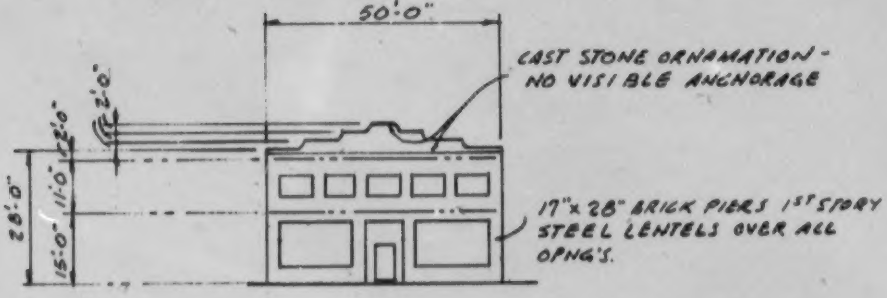


STREET
150'-0"
15'-0"
8 @ 15'-0" = 120'-0"
15'-0"
B
OFF.
T.
T.
MECH.
STREET
A
TIMBER COLS-TYP.
C
20'-6"
9'-6"
20'-6"
50'-0"
ALLEY
DOOR OPNG ONLY
NO OPENINGS
D
N

21. Elevation of Exterior Walls.

Sketch:
- a. All openings or note pattern of openings.
- b. Note exterior finish and appendages.
- c. Note material of walls.
- d. Major cracks or other damage. (Note if cracks are larger at one end.)
- e. Note previously repaired damage.
- f. Note any evidence of damage to cladding or appendages.

(Use additional sheet if necessary)

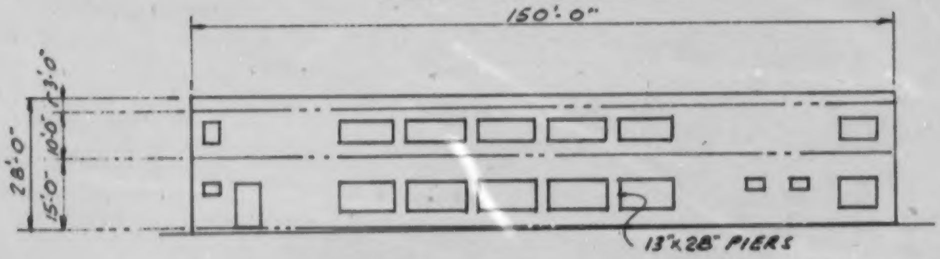


CAST STONE ORNAMATION - NO VISIBLE ANCHORAGE

17" x 28" BRICK PIERS 1ST STORY STEEL LENTELS OVER ALL OPNG'S.

NOTE: EXTERIOR WALLS 13" BRICK - UNREINFORCED. LIME MORTAR - SOFT.

ELEVATION "A"

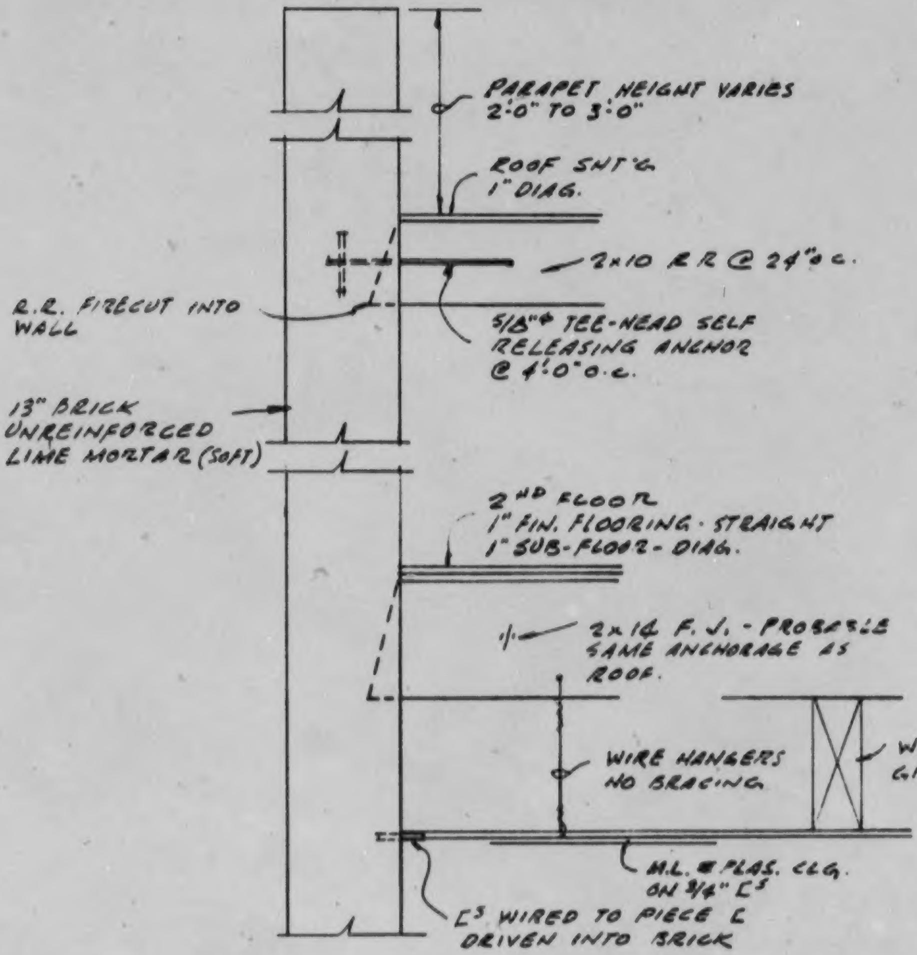


13" x 28" PIERS

NOTE: EXTERIOR WALLS 13" BRICK - UNREINFORCED. LIME MORTAR - SOFT.

ELEVATION "B"

1-DC-3A


PARAPET HEIGHT VARIES 2'-0" TO 3'-0"
ROOF SHT'G. 1" DIAG.
2x10 R.R. @ 24" o.c.
R.R. FIRECUT INTO WALL
5/8"⌀ TEE-HEAD SELF RELEASING ANCHOR @ 4'-0" o.c.
13" BRICK UNREINFORCED LIME MORTAR (SOFT)
2ND FLOOR 1" FIN. FLOORING - STRAIGHT 1" SUB-FLOOR - DIAG.
2x14 F.J. - PROBABLE SAME ANCHORAGE AS ROOF.
WIRE HANGERS NO BRACING
WD GIRDER
M.L. & PLAS. CLG. ON 3/4" [s
[s WIRED TO PIECE [DRIVEN INTO BRICK

TYPICAL WALL SECTION

22. Elevation of Interior Shear Walls. NONE

Sketch: a. All openings.
b. Major cracks or other damage. (Note if cracks are larger at one end.)
c. Note any previously repaired damage.

23. Adaptability of Basement to Storm Shelter. NO BASEMENT

a. Floor Over Basement - Concrete ☐ Other ☐

b. If concrete, give thickness ________

c. Available Space (approximate) ______________ sq. ft.

d. Dangerous Contents. Storage of Flammable Liquids ☐

Presence of Transformers or Other Dangerous Equipment ☐

Other Hazards ______________________________

None ☐

24. Is this a Vault-like Structure? Yes ☐ No ☑

25.

EXTERIOR WALL SUMMARY SHEET

Exterior Characteristics	Side A	Side B	Side C	Side D
Extensive Architectural Ornaments or Veneer	✓			
WALLS				
Metal Curtain Wall				
Precast Concrete Curtain Wall				
Stone				
Brick	✓	✓	✓	✓
Concrete Block				
Concrete				
Other				
For Concrete Block and Brick, indicate R for Running Bond S for Stacked Bond	R	R	R	R
Condition of Wall*	2	2	2	2
OPENINGS				
Percent of Open Area per Story	2ND = 30% 1ST = 60%	2ND = 21% 1ST = 26%	2ND = 0% 1ST = 8%	2ND = 0% 1ST = 0%

*1. No cracks, good mortar.
2. Few visible cracks.
3. Many cracks
4. Evidence of minor repairs.
5. Evidence of many repairs.

B. SITE RELATED INFORMATION

1. Exposure

a. Centers of large city ☐ b. Very rough hilly terrain ☐

c. Suburban areas, towns, city outskirts, wood areas, or rolling terrain ☑ d. Flat, open country ☐

e. Flat coastal belts ☐ f. Other ☐

2. Topography

a. Building on level ground ☑ b. Building on sloping ground ☐

c. Building located adjacent to embankment ☐

*3. Geologic formation —

*4. Location of known faults: Name — Miles —

Miles

*5. Depth of water table — ft. When measured: — (Month) — (Year)

*6. Depth of bedrock — ft.

*7. Soil type —

*8. Bearing capacity — p.s.f., or — blows per inch

9. Proximity to potential wind-blown debris - Type LUMBER

Location LUMBER YARD TO THE NORTH Distance 100'

*To be filled in by Field Supervisor.

/-DC-8

C. STRUCTURAL SYSTEMS

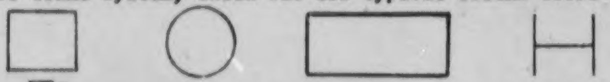
1. Material

Concrete ☐ Masonry ☑ Steel ☐ Wood ☐

2. Vertical Load Resisting System

Frame ☐ Bearing Wall ☐ Wall and Pilasters ☑

For frame system, check one for typical column cross-section



☑ ☐ ☐ ☐ Other ☐

3. Lateral Load Resisting System

Masonry Shear Wall ☑
Concrete Shear Wall ☐
Plywood Shear Wall ☐
Braced Frame ☐
Moment Resisting Frame ☐
Are resisting systems symmetrically located? ☐ Yes ☑ No

4. Floor System

Frame

Concrete Beams ☐
Steel Beams ☐
Steel Bar Joist ☐
Wood Beams ☑
No Framing Members ☐
Precast Concrete Beams ☐

Deck

Concrete Flat Plate ☐
Concrete Flat Slab ☐
Concrete Waffle Slab ☐
Steel Deck ☐
Wood Joists ☑
Wood Plank ☐
Straight Sheathing ☑
Plywood Sheathing ☐
Diagonal Sheathing ☑
Precast Concrete Deck ☐
Concrete Joists ☐
Concrete Plank ☐

Note if concrete topping slab is used over metal decks or concrete plank.

Connection Details

	Framing	Decking To Framing
Bolted	☑	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☑	☑
Metal Hangers	☑	☐

Anchorage Floor to Walls

Type COULDN'T SEE - PROBABLY SAME AS ROOF

Spacing ______

5. Roof System

Frame

Concrete Beams ☐
Steel Beams ☐
Steel Bar Joist ☐
Wood Beams ☑
Wood Rafters ☑

Steel Truss ☐
Wood Truss ☐
No Framing Members ☐
Precast Concrete Beams or Tees ☐

Deck

Concrete Flat Slab ☐
Metal Decking ☐
Concrete Slab ☐
Concrete Joists ☐
Precast Decking ☐

Concrete Waffle Slab ☐
Plywood Sheathing ☐
Diagonal Sheathing ☑
Straight Sheathing ☐
Concrete Fill Yes ☐ No ☑

Connection Details

	Framing	Decking to Framing
Bolted	☑	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☑	☑
Metal Hangers	☑	☐

Anchorage Roof to Walls

Type 5/8"⌀ TEE HEADED SELF RELEASING ANCHOR

Spacing 4'-0" o.c.

D. NONSTRUCTURAL ELEMENTS

1. Partitions

Type

	Typical	Corridor
Partial Height	☐	☐
Full Height Floor-To-Ceiling	☐	☐
* Floor To Floor	☑	☑
Movable	☐	☐

Composition

Lath and Plaster ☑ ON WOOD STUDS

Gypsum Wallboard ☐

Concrete Block ☐

Clay Tile ☐

Metal Partitions ☐

* STUD WALLS IN UPPER STORY NAILED TO RAFTERS AND BLOCKING, 1ST STORY WALLS PROBABLY ARE SIMILARLY NAILED BUT NOT VISIBLE.

2. Ceiling

Typical Room

Material

Acoustical Tile ☐ Gypsum Board ☐ Plaster ☑

Method of Attachment

Suspended ☐ Metal Channels ☑ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

Typical Corridor

Material

Acoustical Tile ☐ Gypsum Board ☐ Plaster ☑

Method of Attachment

Suspended ☐ Metal Channels ☑ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

3. Light Fixtures

Typical Room

Recessed ☑ Surface Mounted ☐ Pendant (Suspended) ☐

Typical Corridor

Recessed ☑ Surface Mounted ☐ Pendant (Suspended) ☐

4. Mechanical Equipment

Location of Mechanical Equipment Room

Basement ☐ Other Floor ☑ Which Floor 1ST

Roof ☐

Is Equipment Anchored to Floor? No ☑ Yes ☐

Location of The Following Units

Liquid Storage Tank NONE

Cooling Tower NONE

Air Conditioning Unit WINDOW UNITS

/- DC-12

5. Roofing

Description

Flat ☑ Arched ☐ Gabled ☐ If arched or gabled, sketch section.

Pitched ☐ Slope (:12)

Parapet No ☐ Yes ☑ Height (2' TO 3' (SEE SKETCH & ELEVATIONS) ft. ______ in.) Thickness (8 in.)

Material MASONRY Special Anchorage or Bracing Yes ☐ No ☑

Type

Built-up gravel ☑ Gravel ☐ Asphalt or Wood Shingles ☐

Clay Tile ☐ Other ☐

6. Windows

Type

Fixed ☑ (LOWER STORY - WALL A Movable ☑ ALL OTHERS

Frame Material:

Aluminum ☐ Steel ☑ Stainless Steel ☐ Wood ☐

Size: Average Size of Casing (___ ft. x ___ ft.) SEE ELEVATIONS

Average Size of Glazing (___ ft. ___ in. x ___ ft. ___ in.)

How Casing is Attached to Structure

Bolted ☐ Screwed ☐ Clipped ☐ Welded ☐ Nailed ☐ IMBEDDED IN MASONRY

Glazing Attachment to Casing

Elastomeric Gasket ☐ Glazing Bead ☑ Aluminum or Steel Retainer ☐

Other ☐

7. Gas Connection

Flexible Connection to Building ☐ Rigid Connection to Building ☑

Automatic Shut-off ☐ None ☑ Unknown ☐

INSPECTED BY ______________________

DATE ______________________

FIELD SUPERVISOR ______________________

C. EARTHQUAKE EVALUATION

The mortar on this building was picked with a knife and found to be soft lime mortar. There was no ceiling in the upper story so the roof construction could be seen. The type of roof anchorage could also be seen and it is assumed that the second floor anchorage is similar. A sketch was made of this detail in the Data Collection Form.

It is noted that Wall D has no openings. This is probably a property line wall. Wall C has only one opening. The other two walls have many openings. A steel plate could be seen over the large windows of Wall A with rivet heads, showing that this plate must be attached to a steel lintel beam.

The 1" diagonal roof sheathing indicates that the roof diaphragm is quite flexible. There are no interior masonry walls, so the diaphragm must span between exterior walls and will be unable to transfer any significant torsional effects. The lateral loads then will be resisted by the exterior wall vertical elements and the lateral loads to each wall will be tributary loads. Thus, the obviously critical wall will be Wall A in the lower story, where there are only four 17" x 28" brick piers. The difference in rigidity between Wall A and Wall C is noted in the Symmetry Rating.

The second floor diaphragm consists of both straight sheathing and diagonal sheathing. This combination produces a more rigid diaphragm than the single diagonal sheathed roof. This is taken into consideration in the rigidity ratings given on 1-Form FMA-2.

Some explanation of the ratings given for "Other Life Hazards" should be given. Under "Partitions Other Than on Corridors and Stair Enclosures," a rating "A" has been given. On 1-DC-10 the partitions are noted to extend full height floor to floor. This could be seen in the upper story and it is probable that this occurs in the first story.

The "Glass Breakage" item is rated "C." The large, front, plate glass windows are very vulnerable. The casing has a projection that appears to be embedded in the masonry. There is no provision for lateral movement in the plane of the glass. Thus, it is anticipated that this glass would crack and shatter if this building were subjected to a strong earthquake.

The "Ceiling" item is rated "B." There was no bracing found, but it is probable that the metal channels are nailed to the wood girders.

"Light Fixtures" are rated "C." They are recessed and no special bracing was noted.

The rating "X" for the cast stone ornamentation on Wall A is because the anchorage is unknown.

A resume of the Field Evaluation is given on 1-Form FME.

/- FORM FMA-1

FACILITY NO. *Example 1* SITE MODIFIED MERCALLI INTENSITY *VII*

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

VERTICAL RESISTING ELEMENTS							
Type	General Rating (GR)		Symmetry (S)	Quantity (Q)	Symmetry Quantity Rating (SQR)	Present Condition (PC)	Sub-Rating (SR1)
	E	W					
TRANSVERSE LOADING							
E	4	3	4	2	3.0	2	2.3
LONGITUDINAL LOADING							
E	4	3	3	1	2.0	2	2.0

NOTES: Symmetry-Quantity Rating (SQR) = $\frac{S + Q}{2}$.

Sub-rating SR-1 = $\frac{SQR + 2PC}{3}$.

	TYPE	GENERAL RATING (GR) Earthquake	GENERAL RATING (GR) Wind
A	Steel Moment Resistant Frames	1	1
B	Steel Frames - Moment Resistance Capability Unknown	2	2
C	Concrete Moment Resistant Frames	1	1
D	Concrete Frames - Moment Resistance Capability Unknown	2	2
E	Masonry Shear Walls - Unreinforced	4	2 or 3
F	Masonry or Concrete Shear Walls - Reinforced	1	1
G	Combination - Unreinforced Shear Walls and Moment Resistant Frames	2	2
H	Combination - Reinforced Shear Walls and Moment Resistant Frames	1	1
J	Braced Frames	1	1
K	Wood Frame Buildings, Walls Sheathed or Plastered	1 or 2	2 or 3
L	Wood Frame Buildings, Walls Without Wood Sheathing or Plaster	4	4

SYMMETRY (of Resisting Elements)	
1	Symmetrical
2	Fairly Symmetrical
2 or 3	Symmetry Poor
3 or 4	Very Unsymmetrical

NOTE: Add 1 (not to exceed 4) to each rating if a high degree of vertical non-uniformity in stiffness occurs.

QUANTITY (of Resisting Elements)	
1	Many Resisting Elements
2	Medium Amount of Resisting Elements
3	Few Resisting Elements
4	Very Few Resisting Elements

NOTE: If exterior shear walls are at least 75% of building length, this rating will be 1.

PRESENT CONDITION (of Resisting Elements)	
1	No Cracks, No Damage
2	Few Minor Cracks
3	Many Minor Cracks or Damage
4	Major Cracks or Damage.

NOTE: If masonry walls, note quality of mortar - good or poor. If lime mortar is poor, use next higher rating.

FACILITY NO. *EXAMPLE 1* 1-FORM FHA-2

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

HORIZONTAL RESISTING ELEMENTS

Type		Rigidity (R)	Anchorage & Connections (A)	Chords (C)		Sub-Rating (SR2)
				Longitudinal	Transverse	
Roof	A	2.5	2	4	4	4.0
Floors	A	2.0	2	4	4	4.0

Note: Sub-rating SR2 = Largest of R, A or C.

Type

A	Diaphragm
B	Steel Horizontal Bracing

Rigidity - Ratings

1.	Rigid
1.5	Semi-rigid
2.0	Semi-flexible
2.5	Flexible

Anchorage and Connections - Ratings

1	Anchorage confirmed - capacity not computed, but probably adequate.
2	Anchorage confirmed - capacity not computed, but probably inadequate.
3	Anchorage unknown.
4	Anchorage absent.

Chords - Ratings

1	Chords confirmed, but capacity not computed.
2	Chords unknown, but probably present.
3	Chords unknown, but probably not present.
4	Chords absent.

FACILITY NO. *EXAMPLE 1*

FIELD EVALUATION METHOD

EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

TYPE OF WALL	REINFORCEMENT			ANCHORAGE					WALL RATING
	Present	Not Present	Not Known	Mortar Only	Dowels	Screws or Bolts	Other	Not Known	
Brick									
Brick									
Concrete Block									
Concrete Block									
Reinforced Concrete									
Tilt-up or Precast Concrete									
Steel Studs & Plaster									
Wood Studs & Plaster								✓	X
Hollow Tile									
Hollow Tile & Plaster									

NOTE: Wall Rating on Basis of A, B, C, and X.

1-FORM FMB-1

FACILITY NO. EXAMPLE 1 1- FORM FMB-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	RATING
Partitions Other Than on Corridors or Stair Enclosures	A
Glass Breakage	C
Ceiling	B
Light Fixtures	C
Exterior Appendages and Wall Cladding*	X

Ratings

A = Good
B = Fair
C = Poor
X = Unknown

*A description of some of the ratings for Exterior Appendages and Wall Cladding are:

Description	Rating
Spacing of anchors appears satisfactory	A
Size and embedment of anchors satisfactory	A
Spacing of anchors appears to be too great	B
Size and embedment of anchors appears unsatisfactory	C
Anchorage unknown	X
Anchorage corroded or obviously loose	C
No anchorage	C

EARTHQUAKE GAS CONNECTION		
Present	Not Present	Not Known
	✓	

D. Wind Evaluation

The same Data Collection Form material is as applicable for wind evaluation as for earthquake. A basic wind speed of 100 miles per hour is assumed with Exposure "B." Because of the light roof and its poor anchorage, and its poor basic structural rating of 3, the "Effective Velocity Pressure Capacity" is relatively low. The information necessary for evaluation of the structural system is given with the earthquake evaluation on 1-Form FME. A resume of the field evaluation is given in section D.2F.

FACILITY NO. EXAMPLE 1 /- FORM FMC-1

FIELD EVALUATION METHOD

STRUCTURAL SYSTEM - WIND RATING

BUILDING DESIGNATION:										
* Exposure A, B or C	* Basic Wind Speed (V_2)	Building Height	* Effective Velocity Pressure (q_F)	**** Design Unit Pressure $q_F x1.4=P$	** Basic Structural Rating	Uplift Anchorage Factors		*** Corrected Structural Rating	Effective Unit Velocity Pressure Capacity P_c	Capacity Ratio $\frac{P}{P_c}$
						Foundation	Roof			
B	100	28'	16	22.4	3.7	1.5	4.0	4.0	5	4.5

* See ANSI A58.1-72. q_F in pound per square foot.

** From Structural Systems - Form FME.

*** Use Maximum Anchorage Factor (Foundation or Roof) or the Basic Structural Rating, whichever is greater.

**** q_F x 1.3 = P for buildings with height to length ratio less than 2.5.

ANCHORAGE FACTORS

BUILDING TYPE	UPLIFT ANCHORAGE TO FOUNDATION	FOUNDATION ANCHORAGE FACTOR[1]	UPLIFT ANCHORAGE OF ROOF	ROOF ANCHORAGE FACTOR[1]
Heavy Buildings	Good	1.0	Good	1.0
Heavy Buildings	Poor	1.5	Poor	4.0
Light Buildings	Good	1.0	Good	1.0
Light Buildings	Poor	4.0	Poor	4.0

CORRECTED STRUCTURAL RATING	P_c
1. -	45
1.1 to 1.5	40
1.6 to 2.0	30
2.1 to 3.0	20
3.1 to 3.5	10
3.6 to 4.0	5

[1] Factors should be increased 0.5 (not to exceed 4.0) if the building is primarily un-enclosed.

/- FORM FMC-1

FACILITY NO. EXAMPLE 1

1- FORM FMC-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - WIND RATING

TYPE OF RISK	RATING
Glass Breakage	B
Window Frame Anchorage	B
Roof Panel Anchorage	C
Wall Panel Anchorage	—
Anchorage of Exterior Appendages	X

A = Good; B = Fair; C = Poor; X = Unknown.

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE

TYPE	QUANTITY	DISTANCE
LUMBER YARD	LARGE	100'

E. Tornado Evaluation

Evaluation of this structure utilizes the same Data Collection material as for earthquake and wind. It is obvious that this building does not conform to the requirements of a Vault-Type structure. Because of the light roof, its poor anchorage and its poor structural rating, the "Effective Velocity Pressure Capacity" is very low (see 1-Form FMC-1) and the tornado rating of the building as a whole is "very poor." The anchorage of the cast stone ornamentation on the front of the building is unknown and rated "Fair." As noted on the Data Collection Form, there is a lumber yard close by which could be a source of danger from windblown debris. There is no basement available as a storm shelter.

FACILITY NO. EXAMPLE 1 1- FORM FMD

FIELD EVALUATION METHOD

TORNADO RATING

EFFECTIVE UNIT VELOCITY PRESSURE CAPACITY P_c (From FMC-1)	DOES BUILDING QUALIFY AS A VAULT-TYPE STRUCTURE?		TORNADO RATING BUILDING-AS-A-WHOLE
5	Yes ☐	No ☑	VERY POOR

BUILDING-AS-A-WHOLE RATINGS

Vault Type Building	- Good
P_c = 40 p.s.f. or over	- Fair
P_c = 20 to 40 p.s.f.	- Poor
P_c = Under 20 p.s.f.	- Very Poor

HAZARD FROM WIND-BLOWN DEBRIS				
	LOCATION	TYPE	NOT PRESENT	RATING
Wall Cladding, Appendages, or Glass	APPENDAGES ON FRONT OF BLD'G.	CAST STONE		FAIR
Other Potential Debris Not Part of The Building	100' NORTH.	LUMBER		POOR

WIND-BLOWN DEBRIS RATINGS

Not Present	- Good
Small Quantity of Potential Hazard	- Fair
Large Quantity of Potential Hazard	- Poor

BASEMENT STORM SHELTER AVAILABILITY		
Present	Yes ☐	No ☑
Capacity*		
Suitability**		

*Based on 15 sq. ft. per person.

**See section 3.2E.

F. Resume

COMMENTS ON RATING RESULTS : (For resume of structural systems ratings, see Form FME)

Earthquake

The Field Evaluation Method rates this building "Poor" for its ability to resist an earthquake of MMI VII. It would probably have some structural damage in an earthquake of MMI VI. The wood stud and plaster partitions would probably have little damage in an earthquake of MMI VI but would have some plaster damage in an earthquake of MMI VII, or greater.

The Other Life Hazards, such as the cast stone parapet ornamentation and glass breakage, are rated "Unknown" and "Poor," respectively.

Wind and Tornado

This example rates "Very Poor" under the Field Evaluation Method for a wind of 100 mph wind velocity. Poor roof anchorage is a major factor in this poor rating. The rating would be much better, of course, for winds of, say, 50 mph. Some glass breakage would be expected in the event of 100 mph winds and the large window frames might be damaged.

The Field Evaluation of this example for Tornado would not ordinarily be made where the evaluation for winds of hurricane intensity is "Poor," since the wind pressures from a "moderate" tornado are more severe. The hazard of a nearby lumber yard is noted as a potential source of flying missiles.

FACILITY NO *EXAMPLE 1* *1-* FORM FME

FIELD EVALUATION METHOD

CAPACITY RATIOS - EARTHQUAKE AND WIND RATING

	General Rating (GR)	Sub-Rating		Basic Structural Rating*	Capacity Ratio**
		SR1	SR2		
EARTHQUAKE	4	2.3	4	4	2.0
WIND	3	2.3	4	3.7	4.5

*Basic Structural Rating = $\frac{\text{GR} + 2\ (\text{Largest of SR1 or SR2})}{3}$.

**Capacity Ratio for wind shall be obtained from Form FMC-1. For earthquake, the ratio is obtained from the Basic Structural Rating divided by the Intensity Level Factor at the site as determined from the table below.

Modified Mercalli Scale	Intensity Level Factor
VIII or Greater	1
VII	2
VI	3
V or Less	4

A description of Modified Mercalli Scale is included on table 3.3.

Capacity Ratio Rating	
Capacity Ratio	Rating (In Terms of Risk)
Less than 1.0	Good
1 through 1.4	Fair
1.5 through 2.0	Poor
Over 2.0	Very Poor

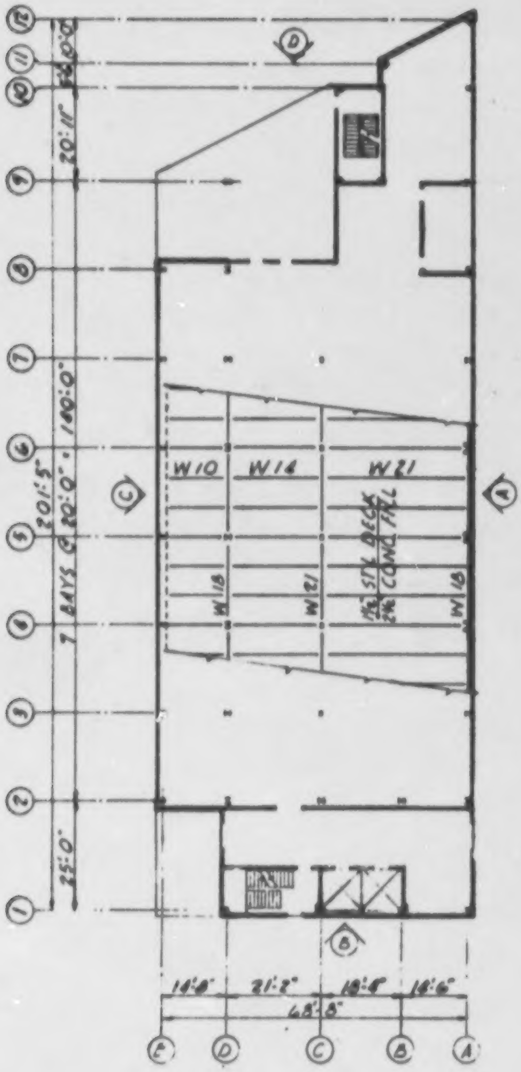
D.3 EXAMPLE 2

A. Preamble

The building chosen for this example is a 6-story steel frame office structure. Steel trusses clear-span the 54 feet building width. For this example, as the plans and calculations were available, only the Approximate Analytical Evaluation Method is used. Some of the pertinent plans follow. The wind calculations were made for low wind pressures. The lateral resistance in the transverse direction is furnished by the truss-column and knee-braced column system acting as moment-resisting frames. In the longitudinal direction, the columns and truss spandrels form a moment-resisting system. The exterior walls are metal studs and plaster. The roof and floor system utilize intermediate steel beams with metal deck and concrete topping.

B. Data Collection Form

The Data Collection Form containing Sheets 2-DC-1 to 2-DC-12 has been completed for the building in Example 2 and is included in this section.

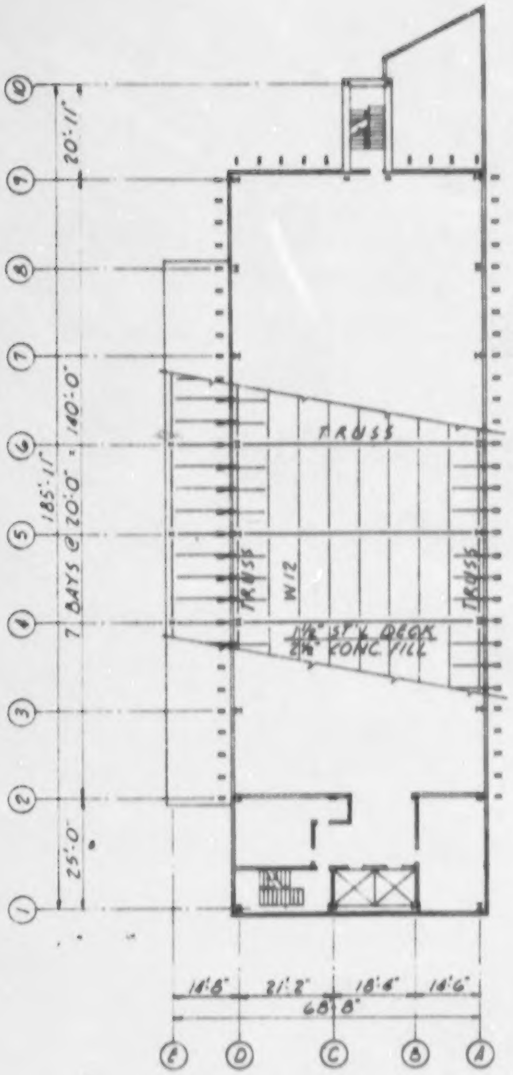

12
11
10
9
8
7
6
5
4
3
2
1
15'-6"
20'-11"
7 BAYS @ 20'-0" = 140'-0"
201'-5"
25'-0"
D
C
A
B
W10
W14
W21
W18
W21
W18
1½" STL DECK
2½" CONC FILL
14'-8"
21'-2"
18'-4"
14'-6"
68'-8"
E
D
C
B
A

N

1ST FLOOR PLAN

FOR USE WITH:
EXAMPLE 2

BUILDING Nº 2	SHT
1ST FLOOR PLAN	1

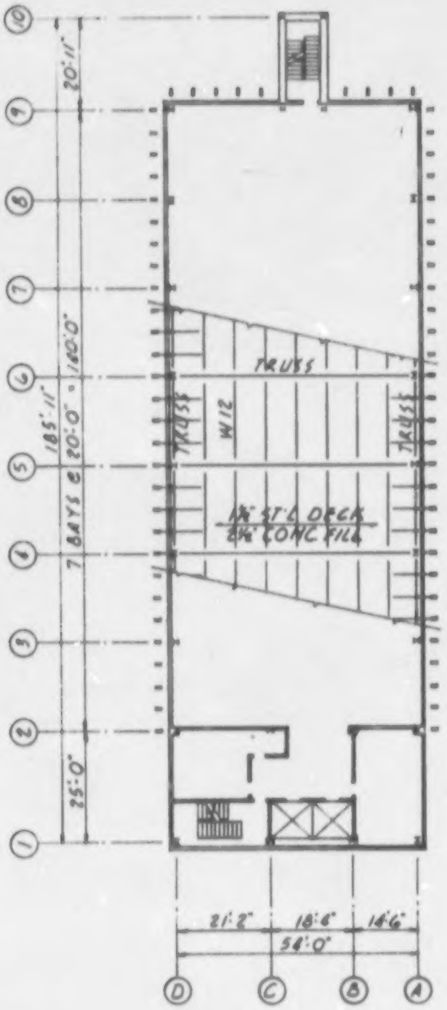

10
9
8
7
6
5
4
3
2
1
20'-11"
185'-11"
7 BAYS @ 20'-0" = 140'-0"
25'-0"
TRUSS
TRUSS
TRUSS
W12
1½" ST'L DECK
2½" CONC FILL
14'-8"
21'-2"
18'-4"
14'-6"
68'-8"
E
D
C
B
A

N

2ND FLOOR PLAN

FOR USE WITH:
EXAMPLE 2

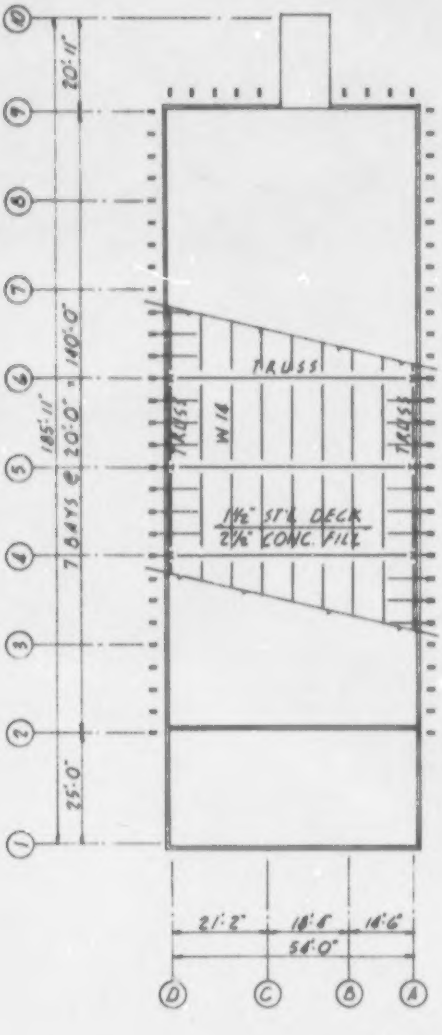
BUILDING Nº 2	SHT
2ND FLOOR PLAN	2


10
9
8
7
6
5
4
3
2
1
20'-11"
185'-11"
7 BAYS @ 20'-0" = 140'-0"
25'-0"
TRUSS
TRUSS
TRUSS
W12
1½" ST'L DECK
2½" CONC FILL
21'-2"
18'-6"
14'-6"
54'-0"
D
C
B
A
N

3RD THRU 6TH FLOOR PLAN

FOR USE WITH:
EXAMPLE 2

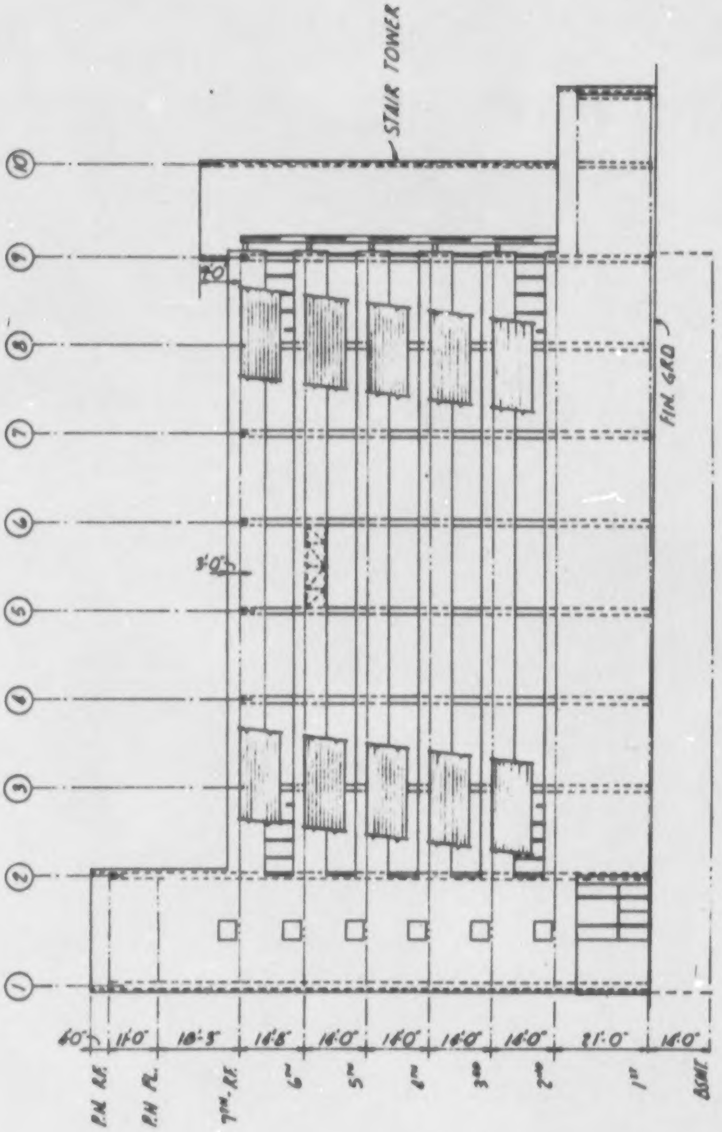
BUILDING No 2	SHT
3RD THRU 6TH FLOOR PLAN	3


10
9
8
7
6
5
4
3
2
1
20'-11"
185'-11"
7 BAYS @ 20'-0" = 140'-0"
25'-0"
TRUSS
TRUSS
W14
TRUSS
1½" ST'L DECK
2½" CONC. FILL
21'-2"
18'-6"
16'-6"
56'-0"
D
C
B
A
N

ROOF PLAN

FOR USE WITH:
EXAMPLE 2

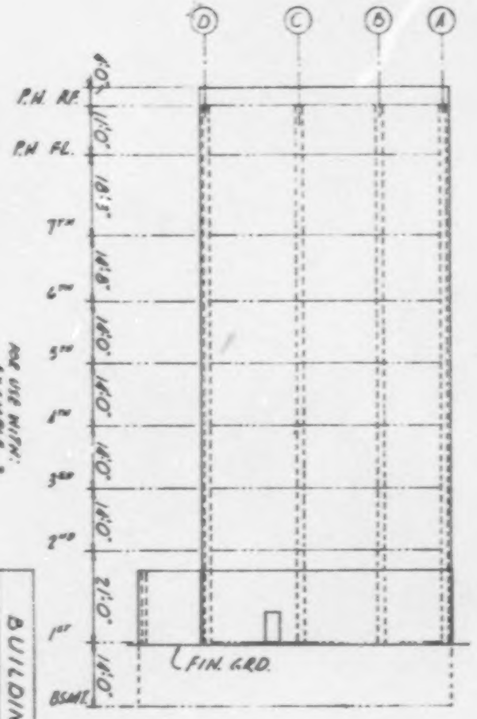
BUILDING Nº 2	SHT
ROOF PLAN	4


STAIR TOWER
FIN. GRD.
⑩
⑨
⑧
⑦
⑥
⑤
④
③
②
①
2'0"
3'0"
6'0"
11'0"
18'5"
16'8"
16'0"
16'0"
16'0"
16'0"
21'0"
16'0"
P.H. RF.
P.H. FL.
7TH. RF.
6TH
5TH
4TH
3RD
2ND
1ST
BSMT.

ELEVATION "A"

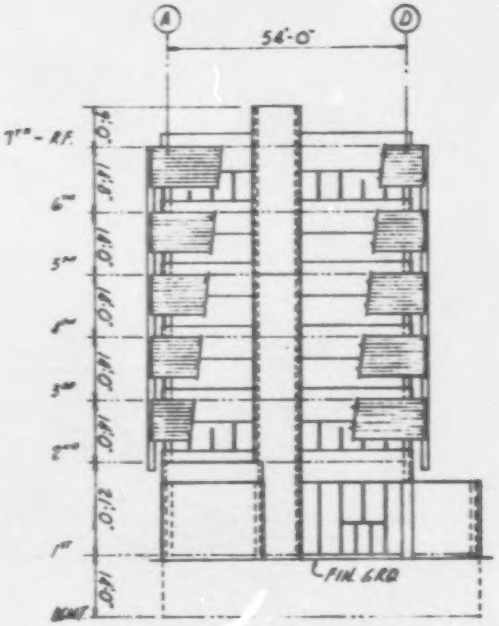
FOR USE WITH:
EXAMPLE 2

BUILDING Nº 2	SHT
ELEVATION "A"	5



D
C
B
A
P.H. RF.
P.H. FL.
7TH
6TH
5TH
4TH
3RD
2ND
1ST
BSMT.
4'-0"
11'-0"
18'-3"
14'-8"
14'-0"
14'-0"
14'-0"
14'-0"
21'-0"
14'-0"
FIN. GRD.

ELEVATION "B"

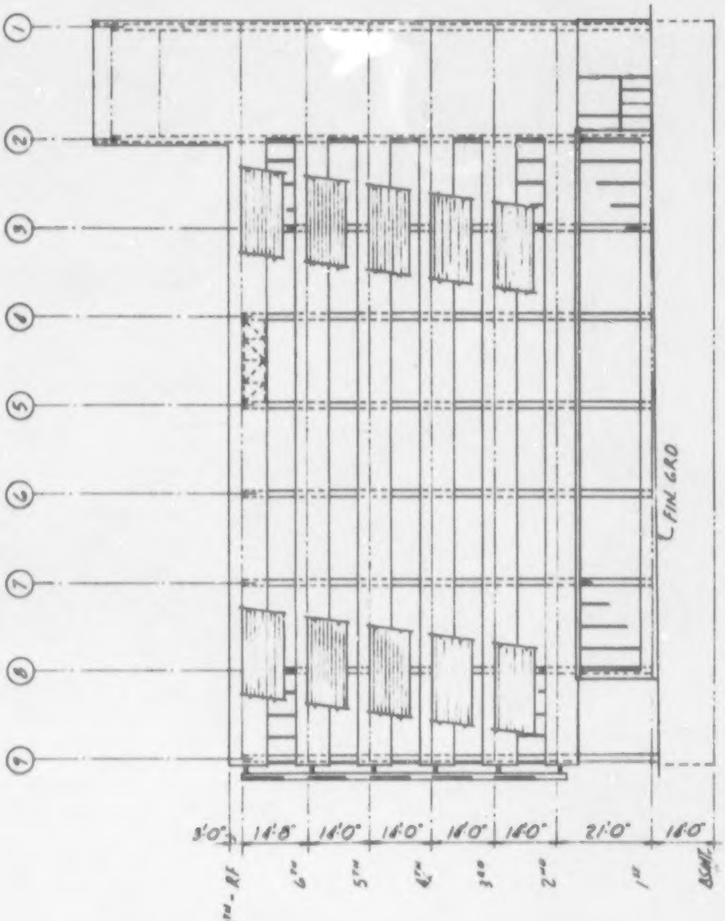


A
D
54'-0"
7TH - RF.
6TH
5TH
4TH
3RD
2ND
1ST
BSMT.
9'-0"
14'-8"
14'-0"
14'-0"
14'-0"
14'-0"
21'-0"
14'-0"
FIN. GRD.

ELEVATION "D"

FOR USE WITH:
EXAMPLE 2

BUILDING Nº 2	SHT
ELEVATIONS B & D	6


1
2
3
4
5
6
7
8
9
FIN GRD
3'-0"
14'-8"
14'-0"
14'-0"
14'-0"
14'-0"
21'-0"
16'-0"
7TH-RF
6TH
5TH
4TH
3RD
2ND
1ST
BSMT.

ELEVATION "C"

FOR USE WITH:
EXAMPLE 2

BUILDING Nº 2	SHT.
ELEVATION "C"	7

2 - DC-1

DATA COLLECTION FORM
NATURAL HAZARDS EFFECTS
(Extreme Winds, Earthquakes)

A. GENERAL DATA

*1. Facility No. — 2. Building Name EXAMPLE 2

3. Address — 4. City —

5. State — 6. Zip Code — 7. Year Built —

8. Date of Major Modifications or Additions, if any —

9. Building Code Jurisdiction: City ☑ County ☐ State ☐ Federal ☐

*10. Latitude — *11. Longitude —

12. Current Bldg. Use OFFICE Orig. Bldg. Use SAME

13. Basement Yes ✓ No ___ Number of Basements 1

No. of Stories Above Basement 6 (See also Item A23)

14. Height of First Story 21 ft.

15. Upper Story Height 14 ft. Special Story Height NONE ft.

16. Is the exterior of first story different from upper stories?

Street Front Side Yes ✓ No ___ Other Sides Yes ✓ No ___

17. Approximate Roof Overhang Distance NONE Side NONE

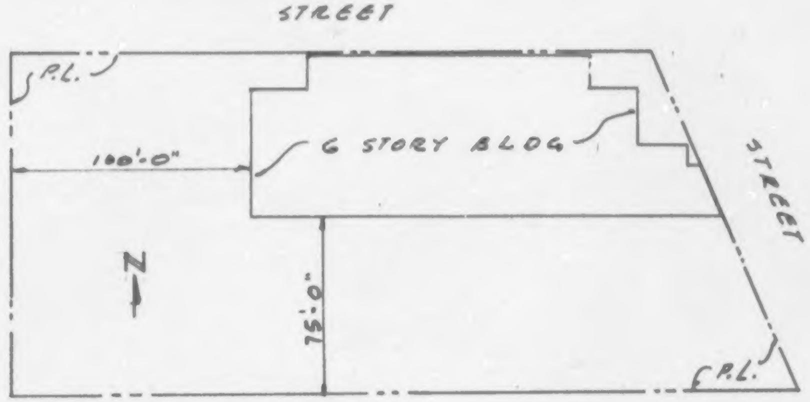
18. Proximity to Adjacent Buildings: Sketch Below with North Arrow

North Side 100' South Side 75' East Side 200' West Side 200'

Note Street or Alley Sides ___

*To be filled in by Field Supervisor.

Sketch



19. Are plans available? YES If so, where obtainable ARCHITECT

Are original calculations available? YES If so, where obtainable ENGINEER

Name of: Architect — Engineer —

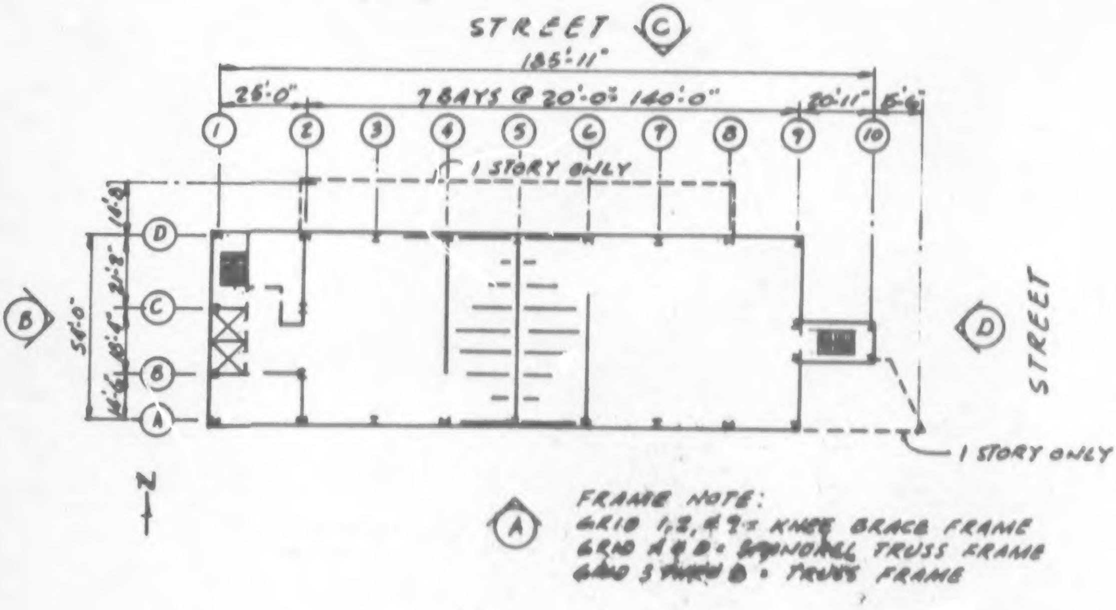
Contractor —

Regulatory Agency CITY

20. Basic Building Plan

a. Sketch overall plan.
b. Locate shear walls, if any.
c. Locate main frames.
d. Locate expansion joints, if any.
e. Give approximate north arrow and label sides "A", "B", "C", "D", etc. Show street or alley sides.
f. Note any common or party walls.
g. If plan changes in upper floors, sketch this plan and note level of change.

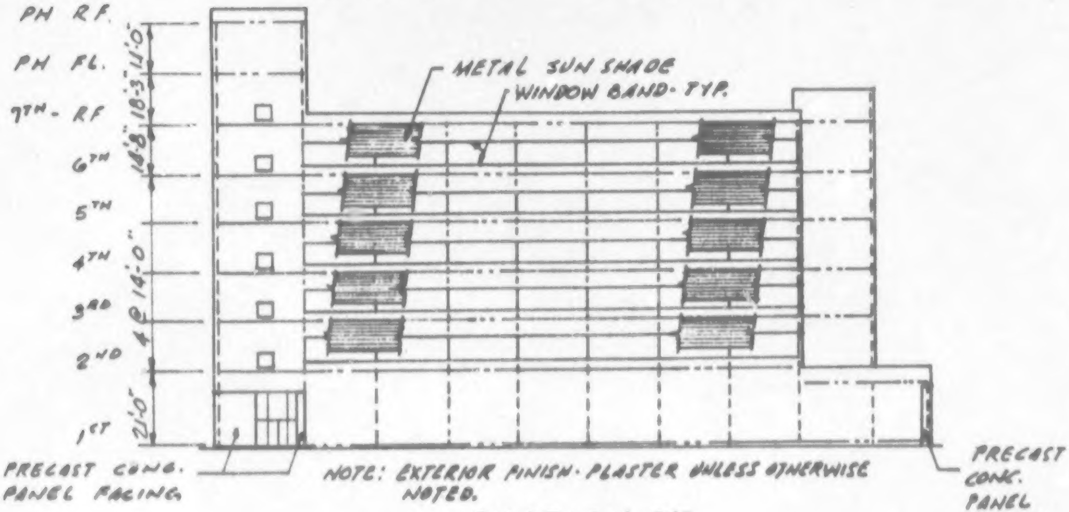
(Use additional sheet if necessary)


STREET
C
185'-11"
25'-0"
7 BAYS @ 20'-0" = 140'-0"
20'-11"
5'-6"
1
2
3
4
5
6
7
8
9
10
1 STORY ONLY
18'-0"
D
C
B
A
21'-8"
18'-4"
14'-0"
56'-0"
B
D
STREET
1 STORY ONLY
N
A
FRAME NOTE:
GRID 1,2,4 9 = KNEE BRACE FRAME
GRID A & D = SPANDREL TRUSS FRAME
GRID 3 THRU 8 = TRUSS FRAME

21. Elevation of Exterior Walls.

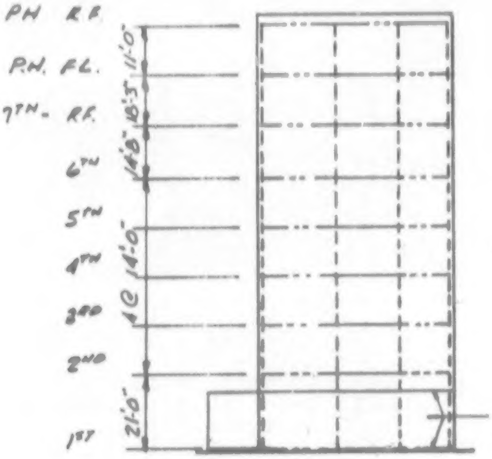
Sketch:
- a. All openings or note pattern of openings.
- b. Note exterior finish and appendages.
- c. Note material of walls.
- d. Major cracks or other damage. (Note if cracks are larger at one end.)
- e. Note previously repaired damage.
- f. Note any evidence of damage to cladding or appendages.

(Use additional sheet if necessary)


PH R.F.
PH FL.
7TH - RF
6TH
5TH
4TH
3RD
2ND
1ST
11'-0"
18'-3"
14'-8"
4 @ 14'-0"
21'-0"
METAL SUN SHADE
WINDOW BAND - TYP.
PRECAST CONC. PANEL FACING
PRECAST CONC. PANEL FACING

NOTE: EXTERIOR FINISH - PLASTER UNLESS OTHERWISE NOTED.

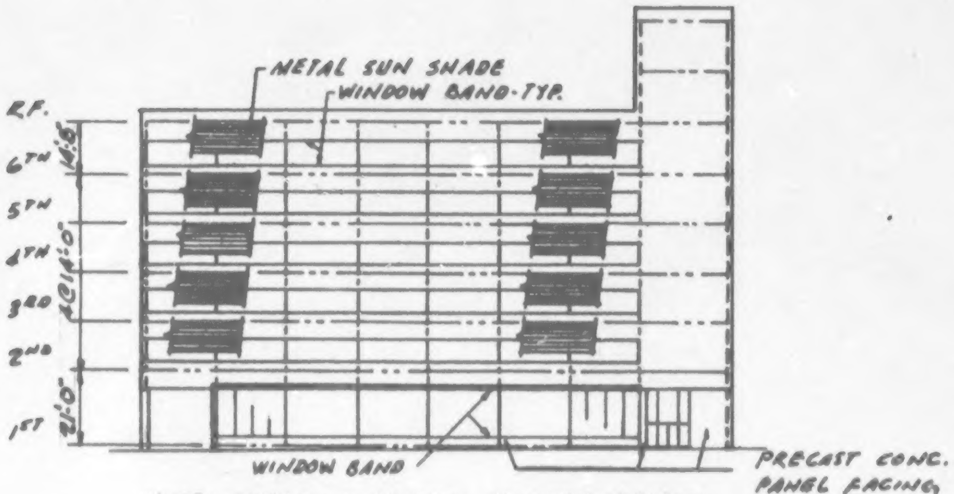
ELEVATION "A"


PH R.F.
P.H. FL.
7TH - RF.
6TH
5TH
4TH
3RD
2ND
1ST
11'-0"
18'-3"
14'-8"
4 @ 14'-0"
21'-0"

NOTE: EXTERIOR FINISH - PLASTER UNLESS OTHERWISE NOTED.

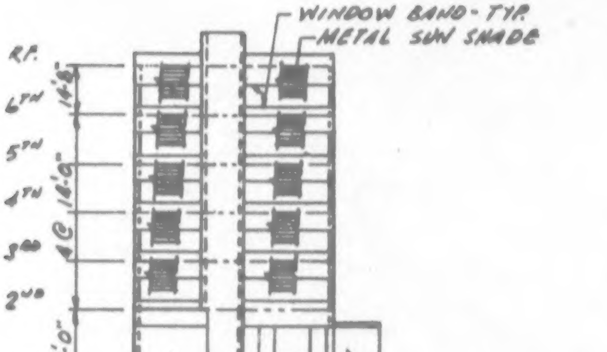
PRECAST CONCRETE PANEL FACING

ELEVATION "B"


METAL SUN SHADE
WINDOW BAND-TYP.
R.F.
6TH
5TH
4TH
3RD
2ND
1ST
14'-8"
4 @ 14'-0"
21'-0"
WINDOW BAND
PRECAST CONC.
PANEL FACING.

NOTE: EXTERIOR FINISH - PLASTER UNLESS
OTHERWISE NOTED.

ELEVATION "C"


WINDOW BAND-TYP.
METAL SUN SHADE
R.F.
6TH
5TH
4TH
3RD
2ND
1ST
14'-8"
4 @ 14'-0"
21'-0"
PRECAST CONC.
PANEL FACING

NOTE: EXTERIOR FINISH - PLASTER UNLESS
OTHERWISE NOTED.

ELEVATION "D"

22. Elevation of Interior Shear Walls. NONE

Sketch: a. All openings.
b. Major cracks or other damage. (Note if cracks are larger at one end.)
c. Note any previously repaired damage.

23. Adaptability of Basement to Storm Shelter.

a. Floor Over Basement - Concrete ☑ Other ☐

b. If concrete, give thickness 2½" CONC. OVER 1½" ST'L. DECK

c. Available Space (approximate) 10,500 sq. ft.

d. Dangerous Contents. Storage of Flammable Liquids ☐

Presence of Transformers or Other Dangerous Equipment ☑

Other Hazards ______________________________

None ☐

24. Is this a Vault-like Structure? Yes ☐ No ☑

25. EXTERIOR WALL SUMMARY SHEET

Exterior Characteristics	Side A	Side B	Side C	Side D
Extensive Architectural Ornaments or Veneer	✓		✓	✓
WALLS				
Metal Curtain Wall				
Precast Concrete Curtain Wall				
Stone				
Brick				
Concrete Block				
Concrete				
Other	ST'L STUD & PLASTER	ST'L STUD & PLASTER	ST'L STUD & PLASTER	ST'L STUD & PLASTER
For Concrete Block and Brick, indicate R for Running Bond S for Stacked Bond				
Condition of Wall*	1	1	1	1
OPENINGS				
Percent of Open Area per Story 2 THRU 6	60%	0%	60%	60%
1ST	.06%	0%	60%	33%

*1. No cracks, good mortar.
2. Few visible cracks.
3. Many cracks
4. Evidence of minor repairs.
5. Evidence of many repairs.

2 - DC-7

B. SITE RELATED INFORMATION

1. Exposure

   a. Centers of large city ☐ b. Very rough hilly terrain ☐

   c. Suburban areas, towns, city outskirts, wood areas, or rolling terrain ☑ d. Flat, open country ☐

   e. Flat coastal belts ☐ f. Other ☐

2. Topography

   a. Building on level ground ☑ b. Building on sloping ground ☐

   c. Building located adjacent to embankment ☐

*3. Geologic formation —

*4. Location of known faults: Name — Miles —

Miles ____

*5. Depth of water table — ft. When measured: — (Month) — (Year)

*6. Depth of bedrock — ft.

*7. Soil type —

*8. Bearing capacity — p.s.f., or — blows per inch

9. Proximity to potential wind-blown debris - Type LUMBER YARD LARGE

Location NORTH Distance 400'

---

*To be filled in by Field Supervisor.

2 - DC-8

C. STRUCTURAL SYSTEMS

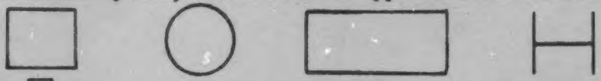
1. Material

Concrete ☐ Masonry ☐ Steel ☑ Wood ☐

2. Vertical Load Resisting System

Frame ☑ Bearing Wall ☐ Wall and Pilasters ☐

For frame system, check one for typical column cross-section



Other

☐ ☐ ☐ ☑ ☐

3. Lateral Load Resisting System

Masonry Shear Wall	☐	Braced Frame	☐
Concrete Shear Wall	☐	Moment Resisting Frame	☑
Plywood Shear Wall	☐	Are resisting systems symmetrically located?	☑ Yes ☐ No

4. Floor System

Frame

Concrete Beams	☐	Wood Beams	☐
Steel Beams	☑	No Framing Members	☐
Steel Bar Joist	☐	Precast Concrete Beams	☐

Deck

Concrete Flat Plate	☐	Straight Sheathing	☐
Concrete Flat Slab	☐	Plywood Sheathing	☐
Concrete Waffle Slab	☐	Diagonal Sheathing	☐
Steel Deck	☑ 2½" CONC TOPPING	Precast Concrete Deck	☐
Wood Joists	☐	Concrete Joists	☐
Wood Plank	☐	Concrete Plank	☐

Note if concrete topping slab is used over metal decks or concrete plank.

Connection Details

	Framing	Decking To Framing
Bolted	☑	☐
Welded	☐	☑
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Floor to Walls

Type PUDDLE WELDS STEEL DECK TO STEEL BEAMS

Spacing 3 PER DECK SHEET

5. Roof System

Frame

Concrete Beams	☐	Steel Truss	☑
Steel Beams	☑	Wood Truss	☐
Steel Bar Joist	☐	No Framing Members	☐
Wood Beams	☐	Precast Concrete Beams or Tees	☐
Wood Rafters	☐		

Deck

Concrete Flat Slab	☐	Concrete Waffle Slab	☐
Metal Decking	☑	Plywood Sheathing	☐
Concrete Slab	☐	Diagonal Sheathing	☐
Concrete Joists	☐	Straight Sheathing	☐
Precast Decking	☐	Concrete Fill	Yes ☑ No ☐

Connection Details

	Framing	Decking to Framing
Bolted	☑	☐
Welded	☐	☑
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Roof to Walls

Type PUDDLE WELDS STEEL DECK TO STEEL BEAMS

Spacing 3 PER DECK SHEET

D. NONSTRUCTURAL ELEMENTS

1. Partitions

Type

	Typical	Corridor
Partial Height	☐	☐
Full Height Floor-To-Ceiling	☑	☑
Floor To Floor	☐	☐
Movable	☐	☐

Composition

Lath and Plaster ☐

Gypsum Wallboard ☑

Concrete Block ☐

Clay Tile ☐

Metal Partitions ☐

2. Ceiling

Typical Room

Material

Acoustical Tile ☑ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☑ Metal Channels ☐ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

Typical Corridor

Material

Acoustical Tile ☑ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☑ Metal Channels ☐ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

3. Light Fixtures

Typical Room

Recessed ☑ Surface Mounted ☐ Pendant (Suspended) ☐

Typical Corridor

Recessed ☑ Surface Mounted ☐ Pendant (Suspended) ☐

4. Mechanical Equipment

Location of Mechanical Equipment Room

Basement ☑ Other Floor ☐ Which Floor ______

Roof ☑

Is Equipment Anchored to Floor? No ☐ Yes ☑

Location of The Following Units

Liquid Storage Tank NONE

Cooling Tower ROOF

Air Conditioning Unit BASEMENT

5. Roofing

Description

Flat ☑ Arched ☐ Gabled ☐ If arched or gabled, sketch section.

Pitched ☐ Slope (1/8 :12)

Parapet No ☐ Yes ☑ Height (3 ft. 0 in.) Thickness (6 in.)

Material STL STUD & PLAS. Special Anchorage or Bracing Yes ☐ No ☑

Type

Built-up gravel ☑ Gravel ☐ Asphalt or Wood Shingles ☐

Clay Tile ☐ Other ☐

6. Windows

Type

Fixed ☑ Movable ☐

Frame Material:

Aluminum ☑ Steel ☐ Stainless Steel ☐ Wood ☐

Size: Average Size of Casing (5'-0" ft. x 6'-6" ft.)

Average Size of Glazing (5 ft. 0 in. x 6 ft. 6 in.)

How Casing is Attached to Structure

Bolted ☐ Screwed ☐ Clipped ☑ Welded ☐ Nailed ☐

Glazing Attachment to Casing

Elastomeric Gasket ☐ Glazing Bead ☑ Aluminum or Steel Retainer ☐

Other ☐

7. Gas Connection

Flexible Connection to Building ☑ Rigid Connection to Building ☐

Automatic Shut-off ☑ None ☐ Unknown ☐

INSPECTED BY ______________________

DATE ______________________

FIELD SUPERVISOR ______________________

C. Earthquake Evaluation

The building had been designed for earthquake using the UBC criteria in effect in 1957 for Zone 3. These criteria are different from UBC 1973. For this reason, new calculations have been made.

For the purpose of this example, the building is assumed to be located where it may be exposed to an earthquake of MMI 9.5. By entering this value into the formula ($2 \log 5Z_s = -1.973 + .375\ \mathrm{MMI}$) (see section 3.3B), the Z_s for the site is determined to be 1.25. This Z_s factor is used for Z in the UBC formula $V = ZKCW$ (equation 14.1) for determining the base shear. The total base shear is distributed to each level in accordance with equation 14-4 and 14-5 of UBC. These equations are $F_t = .004V\left(\frac{h_n}{D_s}\right)^2$ and

$$F_x = \frac{(V - F_t)w_x h_x}{\sum_{i=1}^{n} w_i h_i}$$

. These symbols are defined in Section 2314(i).

Computations for this example have been limited to determining the proper horizontal forces and their distribution, critical elements and critical stress ratio. Overturning of the structure in the transverse direction has also been checked using the resistance to overturning by the vertical loads as determined in the original calculations.

The penthouse is two stories high, but small in plan. In accordance with the provisions in Section 2314(i) of the 1973 Uniform Building Code the penthouse is treated as a separate structure. Its horizontal reactions are applied to the roof of the main building.

Since this structure has a 100% moment-resistant frame, a K factor of 0.67 is used for the base shear computation.

The dead loads used for W were taken from the original calculations, after checking for reasonable compliance with the actual structure.

The horizontal loads in a N-S direction for Column Lines 3 and 4 are illustrated on calculation sheet 2-AM-E3. On Line 3 the frame columns bend about their strong axis and on Line 4 about their weak axis. The first story columns of Lines 3 and 4 were selected as the most critical members by reviewing the original calculations. These columns had the highest stress ratio $\left(\frac{\text{computed stress}}{\text{allowable stress}}\right)$.

The first story columns, because of their height, normally would be suspect in any case. Similarly, a check of the original calculations for the clear span steel trusses indicated that the stresses at the ends of the trusses from lateral force moments could be safely increased in the order of 25%. Therefore, these trusses were not considered to be the most critical elements.

The steel bents in this structure receive lateral forces in proportion to their relative rigidities. In this example some bents are more rigid than others, depending on the direction the columns are oriented. The original calculations computed the story-to-story deflections for a unit load. The reciprocal of this is a measure of the relative rigidity. After these relative rigidities are determined, the horizontal force at each level is distributed to the bents as shown on calculation sheet 2-AM-E-3. The method of distribution, in principle, is illustrated in detail in the example of a two-story structure in section 4.4.

The concrete and metal deck diaphragm used here is considered to be a rigid diaphragm. As such it will deliver torsional loads to the vertical elements. The center of mass and the center of rigidity for each level are computed. The eccentricity between these two centers produces torsional rotation. This results in forces to each bent being added or subtracted to the translational forces. This computation had been made on the original computations. Since for this example only the magnitude of lateral forces has been increased, the effects of torsion can be directly factored, which are shown on the diagram on calculation sheet 2-AM-E3. The method of computing the effect of torsion is illustrated in detail in the example of a two-story structure in section 4.4.

The code criteria upon which the original design was based, included a J factor which reduced the axial loads caused by overturning. This old equation was $J = \frac{0.6}{\sqrt[3]{T}}$ For this example, J was 0.72. The 1973 UBC criteria omits this J factor. Except for this, the bending moments and axial loads due to overturning could have been directly factored from the original calculations. This made it necessary to recompute the effect of overturning. This is shown on calculation sheet 2-AM-E3.

The first story column on Line 3 was first checked for combined axial and bending stresses and the stress ratio determined. These are shown on Sheets 2-AM-E4 and D-5. It is noted that the columns on Line 3 are oriented in the strong direction to resist north-south lateral forces. The combined stresses in the columns on Line 4 are checked on calculation sheet 2-AM-E6. These are oriented in the weak way for resisting north-south lateral forces. The stress ratio for Line 4 columns is higher than that for Line 3 columns. Thus, this becomes the critical stress ratio.

The adequacy of the diaphragm had been determined in the original calculations. Because of the comparatively short spans involved, the margin of safety was quite large and adequate even for these larger seismic forces. For this reason, no diaphragm calculations are included in this exampe.

Because of the light weight of the metal stud and plaster walls, the earthquake forces normal to the walls are very small. Wind would govern the design of these walls. Thus, no computations have been shown in this example for earthquake. In the original calculations the interior partitions were required to resist a 5 psf force normal to the walls. As the original calculations made showed these to be adequate, a stress ratio of <1.0 was given.

The metal sun shades are very light and therefore, wind governs the design of these elements and no earthquake computations are made. For this reason, the critical stress ratio for these elements for earthquake is listed as <1.0.

From the limited number of calculations necessary for this example, it is obvious that the availability of the original calculations saved a great deal of time in the analysis of this structure even though the earthquake forces are of a different magnitude and the overturning criteria changed.

DESIGN CRITERIA

LOAD CRITERIA (FROM ORIGINAL CALCULATIONS)

LOADS TO DETERMINE MASS OF BUILDING INCLUDES FLOOR, ROOF, EXTERIOR WALL AND PARTITION DEAD LOADS:

PENTHOUSE ROOF = 101 p.s.f.
PENTHOUSE FLOOR = 123
7TH FLOOR = 112
MAIN ROOF = 80
2ND TO 6TH FLOORS = 93
LOW ROOF = 83

THE DEAD AND LIVE LOAD AXIAL LOADS AND MOMENTS IN COLUMNS ARE TAKEN FROM THE ORIGINAL CALCULATIONS.

EARTHQUAKE CRITERIA (CHAPTER 23 - 1973 U.B.C.)

$V = ZKCW$ (14-1)
$Z = Z_3 = 1.25$
$K = 0.67$ 100% MOMENT RESISTANT FRAME BUILDING
$T = 0.10N = 0.1 \times 6$ STORIES $= 0.60$
$C = \frac{.05}{\sqrt[3]{T}} = \frac{.05}{\sqrt[3]{.60}} = .059$ - MAIN PORTION OF THE BUILDING
$C = 0.10$ MINIMUM FOR 2 STORY PENTHOUSE
SINCE $\frac{h_n}{D} = \frac{92'}{56'} = 1.16 < 3.0$, $F_t = 0$

STEEL DESIGN CRITERIA

ASTM A-7 STEEL, $F_y = 33$ k.s.i.
1969 AISC SPECIFICATIONS

MEMBERS TO BE CHECKED

FIRST STORY COLUMNS ON LINES 3 AND 4 WHICH HAVE THE HIGHEST STRESS RATIOS IN THE ORIGINAL CALCULATIONS WILL BE CHECKED.

SEISMIC ANALYSIS

BUILDING MASS, BASE SHEAR AND DISTRIBUTION OF SHEAR AT EACH LEVEL

LEVEL	AREA S.F.	D.L. K.S.F.	W_x K	h_x ft.	$W_x h_x$	$\frac{W_x h_x V}{\Sigma W_x h_x} = F_x$	V_x
PTHSE. ROOF	1350	.101	136	29.25	1053	6.5	6.5
PTHSE. FLOOR	1350	.123	166 302^K	18.25	3030 4083	18.8 25.3^K	25.3
	PENTHOUSE BASE SHEAR $V_{PH} = 1.25 \times .10 \times .67 \times 302 = 25.3^K$						
7TH ROOF	1350 7760	.112 .080	795	91.7	72,901	65.8	91.1
6TH	9110	.093	847	77	65,219	58.9	150.0
5TH	9110	.093	847	63	53,361	48.1	198.1
4TH	9110	.093	847	49	41,503	37.5	235.6
3RD	9110	.093	847	35	29,645	26.8	262.4
2ND LOW ROOF	9110 1800	.093 .083	996	21	20,916	18.9	281.3
1ST							

$\Sigma W = 5179^K$ $\Sigma = 283,545$

$$\begin{array}{r} 256.0^K \\ \underline{25.3} \\ 281.3^K \end{array}$$

TOTAL BASE SHEAR

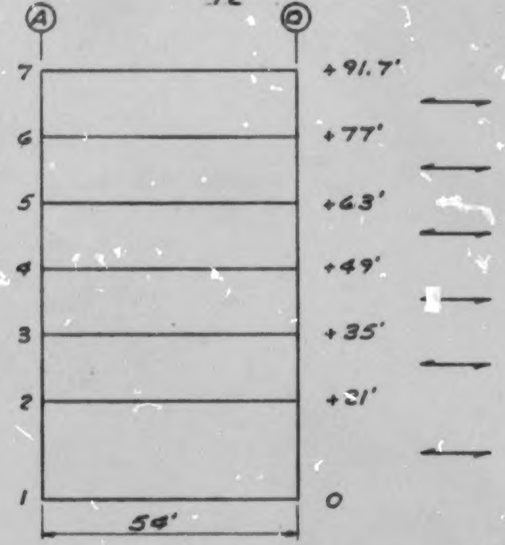
$V = ZKCW = 1.25 \times .67 \times .059 \times 5179 = 256^K + 25.3^K = 281.3^K$

RATIO OF SHEAR AT ROOF TO WEIGHTS OF ROOF AND ABOVE $\frac{91.1}{1097} = .083$, THEREFORE C=0.10 FOR PENTHOUSE IS CORRECT.

SEISMIC ANALYSIS

DISTRIBUTION OF SHEARS TO FRAMES ON LINES 3 AND 4

TO DETERMINE THE SHEARS TO FRAMES 3 AND 4 DUE TO THE TRANSVERSE (N-S) SEISMIC LOADS, THE STORY SHEARS ARE DISTRIBUTED TO THE FRAMES IN PROPORTION TO THEIR RELATIVE STIFFNESSES. THE STORY SHEARS, INCLUDING THE EFFECTS OF TORSION, HAVE BEEN PRORATED USING THE RELATIVE STIFFNESSES OF THE FRAMES AS SHOWN IN THE ORIGINAL CALCULATIONS. FOR EXAMPLE ON LINE 3 AT 7TH LEVEL; ORIGINAL SHEAR ON LINE 3 WAS 19.4^K, ORIGINAL STORY SHEAR WAS 72^K NEW STORY SHEAR = 91.1^K (SHEET 2-AM-E2) ∴ NEW LINE 3 SHEAR = $\frac{19.4}{72} \times 91.1 = 24.6^K$



STORY SHEARS LINE 3	STORY SHEARS LINE 4
24.6^K	11.8^K
36.8	17.7
46.8	22.5
54.8	26.3
60.1	28.8
65.0	31.2

OVERTURNING MOMENTS AND AXIAL LOADS ON COLUMNS

OVERTURNING - LINE 3						OVERTURNING - LINE 4			
LEVEL	HEIGHT	STORY SHEAR K	O.T.M. 'K	ΣOTM 'K	AXIAL LOAD K	STORY SHEAR K	O.T.M. 'K	ΣOTM 'K	AXIAL LOAD K
7	14.7'	24.6	362	362	6.7	11.8	174	174	3.2
6	14.0'	36.8	515	877	16.2	17.7	247	421	7.8
5	14.0'	46.8	655	1532	28.4	22.5	314	735	13.6
4	14.0'	54.8	764	2296	42.5	26.3	368	1103	20.4
3	14.0'	60.1	841	3137	58.1	28.8	404	1507	27.9
2	21.0'	65.0	1363	4500	83.3	31.2	655	2162	40.0

SEISMIC ANALYSIS

1^{ST} STORY COLUMNS ON LINE 3 FOR BENDING ABOUT MAJOR AND MINOR AXES

COLUMN W14 x 202
A-7 STEEL $F_y = 33$ K.S.I.

$A = 59.39^{\square''}$
$S_{xx} = 324.9''^3$ $\quad r_{xx} = 6.54''$
$S_{yy} = 124.4''^3$ $\quad r_{yy} = 4.06''$

COLUMN ALLOWABLE STRESS:

COLUMN LENGTH = 17' UNBRACED - BOTH DIRECTIONS
FROM 1969 AISC SPECIFICATIONS FIG. C1.8.2

$$\text{FOR } K\ell/r_x \quad G = \frac{\Sigma \frac{I_c}{L_c}}{\Sigma \frac{I_g}{L_g}} = \frac{\frac{2538}{17}}{\frac{40200}{54}} = .20 \qquad \text{FOR } K\ell/r_y \; G = \frac{\frac{980}{17}}{\frac{40200}{20}} = .02$$

$K = 2.0$
$X = \text{AXIS}$

$K = 1.0$
$y = \text{AXIS}$

$$K\ell/r_{xx} = \frac{2 \times 17 \times 12}{6.54} = 62.4 \qquad K\ell/r_{yy} = \frac{1 \times 17 \times 12}{4.06} = 50.2$$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = 131.6$$

$$F_a = \frac{\left[1 - \frac{(K\ell/r)^2}{2C_c^2}\right] F_y}{5/3 + \frac{3(K\ell/r)}{8C_c} - \frac{(K\ell/r)^3}{8C_c^3}} = \frac{\left[1 - \frac{(62.4)^2}{2 \times 131.6^2}\right] \times 33}{5/3 + \frac{3 \times 62.4}{8 \times 131} - \frac{(62.4)^3}{8 \times 131.6^3}} = \frac{29.29}{1.67 + .178 - .01}$$

$F_a = 15.96$ K.S.I.

$$F'_{ex} = \frac{12\pi^2 E}{23\left(K\frac{\ell_b}{r_b}\right)^2} = \frac{12 \times \pi^2 \times 29 \times 10^6}{23 \times 62.4^2} = 38.31 \text{ K.S.I.}$$

$$F'_{ey} = \frac{12\pi^2 E}{23 \times 50.2^2} = 59.2 \text{ K.S.I.}$$

$F_b = .66 F_y = .66 \times 33 = 21.8$ K.S.I.

$$\frac{b_f}{2t_f} < \frac{52.2}{\sqrt{F_y}} \quad \therefore F_{by} = .75 F_y = .75 \times 33 = 24.75 \text{ K.S.I.}$$

SEISMIC ANALYSIS

1ST STORY COLUMNS ON LINE 3 FOR BENDING ABOUT MAJOR AXIS

LOADS ON COLUMNS - LINE 3 - 1ST STORY:

AXIAL: DEAD PLUS LIVE = 413^K - FROM ORIGINAL CALCULATIONS
N-S OVERTURNING = 83.3^K

BENDING MOMENTS:

DEAD PLUS LIVE = 49^{IK} - FROM ORIGINAL CALCULATIONS
N-S SEISMIC = 275^{IK} - PRORATED FROM ORIGINAL CALCULATIONS
E-W BENDING = 6.3^{IK} DUE TO TORSION OF N-S SEISMIC

STRESS RATIOS FOR AXIAL AND BENDING
(SEE SHEET 2-AM-E4 FOR ALLOWABLE STRESSES) (AISC 16-1a)

GRAVITY LOADS:

$$\frac{f_a}{F_a} = \frac{413/59.4}{15.96} = \frac{6.95}{15.96} = .436$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85\,(49 \times 12)/325}{\left(1-\frac{6.95}{38.31}\right)21.8} = \frac{1.53}{17.85} = \underline{.086}$$

$$\Sigma = .522$$

SEISMIC LOADS

$$\frac{f_a}{F_a} = \frac{83.3/59.4}{15.96} = \frac{1.40}{15.96} = .088$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85 \times (275 \times 12)/325}{\left(1-\frac{8.35}{38.31}\right)21.8} = \frac{8.63}{17.05} = .506$$

$$\frac{C_{my} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85 \times (6.3 \times 12)\,124.4}{\left(1-\frac{8.35}{59.2}\right)24.75} = \frac{.516}{21.26} = \underline{.024}$$

$$\Sigma = .619$$

$$\text{STRESS RATIO} = \frac{.619}{1.33-.522} = .766 \text{ O.K.}$$

SEISMIC ANALYSIS

1ST STORY COLUMNS ON LINE 4 FOR BENDING ABOUT MINOR AXIS

LOADS ON COLUMNS - LINE 4 - 1ST STORY

AXIAL: DEAD PLUS LIVE = 413^{K} - FROM ORIGINAL CALCULATIONS
N-S OVERTURNING = 40.0^{K}

BENDING MOMENTS:

DEAD PLUS LIVE = $26^{'K}$ - FROM ORIGINAL CALCULATIONS
N-S SEISMIC = $208^{'K}$ - PRORATED FROM ORIGINAL CALCULATIONS
E-W BENDING = $4.8^{'K}$ - DUE TO TORSION OF N-S SEISMIC

STRESS RATIOS FOR AXIAL AND BENDING
(SEE SHEET 2-AM-G4 FOR ALLOWABLE STRESSES)(AISC 1.6-1a)

GRAVITY LOADS:

$$\frac{f_a}{F_a} = \frac{413/59.4}{15.96} = \frac{6.95}{15.96} = .436$$

$$\frac{C_{mx} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85\times(26\times12)/124.4}{\left(1-\frac{6.95}{59.2}\right)24.75} = \frac{2.13}{21.84} = \underline{.098}$$

$$\Sigma = .534$$

SEISMIC LOADS:

$$\frac{f_a}{F_a} = \frac{40.0/59.4}{15.96} = \frac{.68}{15.96} = .042$$

$$\frac{C_{mx} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85\times(208\times12)/124.4}{\left(1-\frac{7.63}{59.2}\right)24.75} = \frac{17.05}{21.36} = .791$$

$$\frac{C_{my} f_{by}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85\times(4.8\times12)/325}{\left(1-\frac{7.63}{38.31}\right)21.8} = \frac{.17}{17.36} = \underline{.008}$$

$$\Sigma = .841$$

STRESS RATIO $= \frac{.841}{1.33-.534} = 1.056$ THIS IS CRITICAL STRESS RATIO FOR COLUMNS. ENTER IN 2-FORM-AMA-1.

FACILITY NO. EXAMPLE 2

FORM AMA-1

APPROXIMATE ANALYTICAL METHOD
STRUCTURAL SYSTEMS - EARTHQUAKE RATING

BUILDING DESIGNATION:							
Type of Frame	Type of Diaphragm	Modified Mercalli Intensity	Z_s	Z_c	Critical Elements		Critical Stress Ratio (f_s/f_a)
					Type	Location	
A	2½" CONC. FILL ON 1½" STEEL DECK	9.5	1.25	1.0	COL.	1ST STORY	1.06

TYPE

- A Steel Moment Resistant Frames
- B Steel Frames - Vertical Load Carrying Only
- C Concrete Moment Resistant Frames
- D Concrete Frames - Vertical Load Carrying Only
- E Masonry Shear Walls - Unreinforced
- F Masonry or Concrete Shear Walls - Reinforced
- G Combination - Unreinforced Shear Walls and Moments Resistant Frames
- H Combination - Reinforced Shear Walls and Moment Resistant Frames
- J Braced Frames
- K Wood Frame Buildings, Walls Sheathed or Plastered
- L Wood Frame Buildings, Walls Without Wood Sheathing or Plaster
- M Other

Z_s = Zone factor determined for site from Modified Mercalli Intensity.

Z_c = Zone factor from Code.

NOTE: For rating of Structural Systems, use Form AME.

FACILITY NO. EXAMPLE 2

APPROXIMATE ANALYTICAL METHOD
EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

Type of Wall	Reinforcement		Anchorage				Critical Stress Ratio f_e/f_a	Rating*
	Present	Not Present	Mortar Only	Dowels	Screws or Bolts	Other		
Brick		×						
Brick		×						
Concrete Block		×						
Concrete Block		×						
Reinforced Concrete		×						
Tilt-up or Precast Concrete		×						
Steel Studs & Plaster	×					WELDS	< 1.0	GOOD
Wood Studs & Plaster		×						
Hollow Tile		×						
Hollow Tile & Plaster		×						
		×						

*Obtained from Form AME - Rating of Critical Stress Ratios.

FACILITY NO. EXAMPLE 2 FORM AMB-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING*
Partitions Other Than on Corridors or Stair Enclosures	< 1.0	GOOD
Exterior Appendages and Wall Cladding	< 1.0	GOOD
Ceiling	NOT BRACED	POOR
Light Fixtures	RECESSED INTO UNBRACED CEILING	POOR

*See Form AME - Rating of Critical Stress Ratios.

D. Wind Evaluation

It is assumed that the structure is located where it will be subjected to a basic wind speed of 90 miles per hour, Exposure "B." This gives a larger wind force on the building than was used in the original calculations.

The computations for this example have been carried only so far as to determine the forces on the building as a whole and determine the critical element and the critical stress ratio. The lateral force distributions have been pro-rated from the original calculations. The contributions of vertical loads are those in the original calculations.

The wind forces q_F are taken from table 5, Exposure B, ANSI 1972 for a Basic Wind Speed of 90 miles per hour for the various height levels of the building. These are shown in the tables on calculation sheet 2-AM-3 where the forces are given for each level. The q_F values are multiplied by 1.3 to be in accordance with table 7 of ANSI for the effect of both windward and leeward pressures on the building as a whole. This is done for both north-south and east-west directions. Because of the greater exposure to north-south winds, this wind direction is the most critical.

The relative stiffness of bents, centers of rigidity and wind forces had originally been computed for lesser wind forces and for a different vertical distribution. However, the center of wind loads at each level was nearly the same and the small differences in eccentricity were considered negligible. Therefore, that portion of the wind load at any level going to any bent could be obtained by a direct ratio of loads. The diaphragm was considered to be rigid for distribution of lateral forces.

The original calculations were checked to find which elements had the highest stress ratios (design stresses/allowable) under combined vertical and lateral loads. Since the vertical loads are the same as for the original calculations, variations in the lateral forces alone will vary the stress ratios but not in direct proportion. However, these stress ratios from the original design calculations serve as a very good clue.

The highest stress ratios in the original calculations occurred in the first story columns in Lines 3 and 4. There was considerable margin of safety in the horizontal trusses and their end connections so these were not investigated. A check was made, however, on the fourth story column on Line 3 which in the original calculations had the highest stress ratio in the upper stories.

The stress ratio for the new wind load criteria was found to be highest for the first story columns on Line 4 and these are the critical elements for the building as a whole.

The adequacy of the exterior steel stud and plaster walls was checked at the penthouse where the wind load was the highest and the vertical span of the studs the greatest. This computation is shown on calculation sheet 2-AM-W9.

Computations for uplift on the roof were not made because the uplift forces are less than the dead load, as indicated in the original calculations.

The precast concrete panels are attached to the steel frame in such a manner as to permit lateral sway of the frame. For normal loads, the panels are attached to the lower flanges of the spandrel beams with clip angles and 5/8"Ø bolts at 3 ft centers. These connections were designed for a 15 psf wind which at this first story level is greater than the wind force the structure is being checked for. For this reason, the stress ratio given is simply <1.0.

The exterior architectural fins or screens are anchored by complicated steel details to the main frame. Since the upper stories of this building were designed for a 20 psf wind pressure which is approximately the same criteria for which the building is being checked, no additional calculations are made and the stress ratio for "Anchorage of Exterior Appendages" is noted as <1.0.

2-AM-W1

DESIGN CRITERIA

LOAD CRITERIA (FROM ORIGINAL CALCULATIONS)

DEAD LOADS:

PENTHOUSE ROOF = 91 p.s.f.
PENTHOUSE FLOOR = 103 " INCLUDING MECHANICAL
7TH FLOOR = 102 "
MAIN ROOF = 75 "
2ND TO 6TH FLOORS = 73 "
LOW ROOF = 75 "

LIVE LOADS:

ROOFS = 20 p.s.f.
FLOORS = 50 "

THE DEAD AND LIVE LOAD AXIAL LOADS AND MOMENTS IN COLUMNS ARE TAKEN FROM THE ORIGINAL CALCULATIONS.

WIND CRITERIA (ANSI A58.1 - 1972)

BASIC WIND SPEED = 90 m.p.h. EXPOSURE 'B'
EFFECTIVE VELOCITY PRESSURE AT 30 ft. ELEVATION
q_F = 16 p.s.f. (TABLE 5)

EXTERNAL PRESSURE COEFFICIENTS FOR WALLS, C_p
WINDWARD WALL = 0.8
LEEWARD WALL = 0.5
TOTAL DESIGN WIND = 1.3

UPLIFT PRESSURE COEFFICIENTS ON ROOF = -0.7 (SECT. 6.5.3.2.1)

LOCAL PRESSURE ON WALLS AT CORNERS = -2.0 (SECT. 6.5.3.1)

STEEL DESIGN CRITERIA

STRUCTURAL STEEL - ASTM A-7, F_y = 33 k.s.i., 1969 AISC SPECIFICATIONS

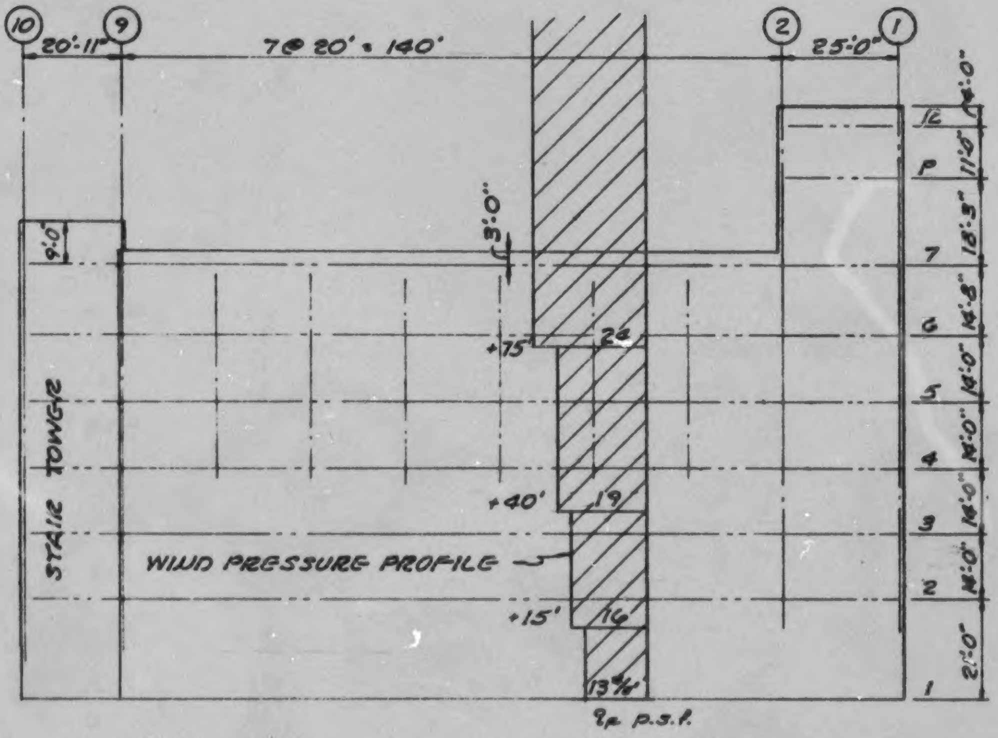
STEEL STUDS - AISI SPECIFICATIONS FOR THE DESIGN OF COLD FORMED STEEL STRUCTURAL MEMBERS - 1968 ED.

MEMBERS TO BE CHECKED

FIRST AND FOURTH STORY COLUMNS ON LINES 3 AND 4 WHICH HAVE THE HIGHEST STRESS RATIOS IN THE ORIGINAL CALCULATIONS WILL BE CHECKED.

WIND ANALYSIS

WIND PRESSURE DISTRIBUTION



10
9
2
1
20'-11"
7@ 20' = 140'
25'-0"
4'-0"
12
11'-0"
P
18'-3"
7
14'-8"
6
14'-0"
5
14'-0"
4
14'-0"
3
14'-0"
2
21'-0"
1
9'-0"
3'-0"
STAIR TOWER
+75'
26
+40'
19
WIND PRESSURE PROFILE
+15'
16
13¾
q_p p.s.f.

NORTH ELEVATION

HATCHED AREA SHOWS VARIATIONS IN PRESSURE ON THE PROFILE

USING STEP FUNCTION METHOD - PRESSURE CHANGE AT +15', +40' & +75'

EXTERNAL PRESSURE COEFFICIENTS:

$$\frac{\text{HEIGHT}}{\text{WIDTH}} = \frac{121}{54} = 2.24$$

LESS THAN 2.5 ∴ COEFFICIENT ON LEEWARD WALL = 0.5
COEFFICIENT ON WINDWARD WALL = 0.8
$1.3 q_p$ = PRESSURE ON BUILDING

WIND ANALYSIS

WIND FORCES AND SHEARS AT EACH LEVEL

N-S WIND

LEVEL	HEIGHT	q_F p.s.f.	TRIB. HEIGHT	LENGTH	WIND FORCE $1.3q_F A$	STORY SHEAR
R	121	24	9.5	27	8,003	8.0^k
P	110	24	14.65	27	12,341	20.3
7	91.7	24 24 24	16.5 10.35 16.35	27 140 22	13,900 45,280 11,222	90.7
6	77	24 19	9.35 5.0	188 188	54,843 23,218	168.8
5	63	19	14.0	188	65,010	233.8
4	49	19	14.0	188	65,010	298.8
3	35	19 16	2.0 12.0	188 188	9,287 46,925	355.0
2	21	16 13	13.0 4.5	188 188	50,835 14,297	420.1

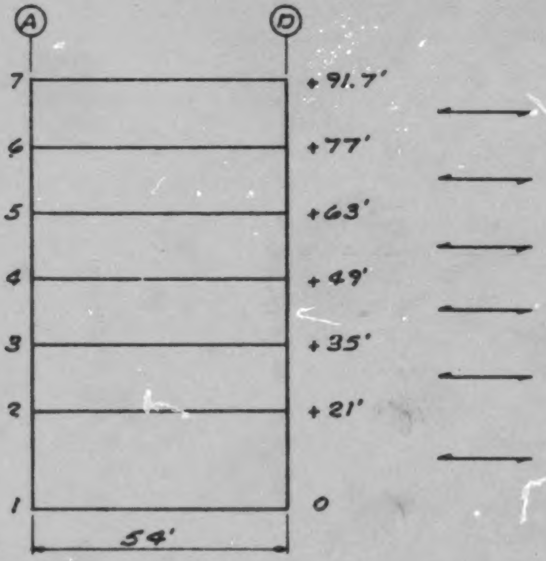
E-W WIND

R	121	24	9.5	56.5	16,747	16.7^k
P	110	24	14.65	56.5	25,825	42.6
7	91.7	24	16.5	56.5	29,086	71.7
6	77	24 19	9.35 5.0	56.5 56.5	16,482 6,978	95.1
5	63	19	14.0	56.5	19,538	114.7
4	49	19	14.0	56.5	19,538	134.2
3	35	19 16	2.0 12.0	56.5 56.5	2,791 14,102	151.1
2	21	16 13	13.0 4.5	56.5 56.5	15,278 4,297	170.7

WIND ANALYSIS

DISTRIBUTION OF SHEARS TO FRAMES ON LINES 3 AND 4

TO DETERMINE THE SHEARS TO FRAMES 3 AND 4 DUE TO THE TRANSVERSE (N-S) WIND LOADS, THE STORY SHEARS ARE DISTRIBUTED TO THE FRAMES IN PROPORTION TO THEIR RELATIVE STIFFNESSES. THE STORY SHEARS, INCLUDING THE EFFECTS OF TORSION, HAVE BEEN PRORATED USING THE RELATIVE STIFFNESSES OF THE FRAMES AS SHOWN IN THE ORIGINAL CALCULATIONS. FOR EXAMPLE ON LINE 3 AT 7TH LEVEL; ORIGINAL SHEAR ON LINE 3 WAS 11.35^K ORIGINAL STORY SHEAR WAS 42^K NEW STORY SHEAR = 90.7^K (SHEET 2-AM-W3) ∴ NEW LINE 3 SHEAR = $\frac{11.35}{42} \times 90.7 = 24.5^K$



STORY SHEARS LINE 3	STORY SHEARS LINE 4
24.5^K	11.7
40.7	79.4
54.2	25.8
67.8	32.3
79.3	37.8
96.0	45.8

OVERTURNING MOMENTS AND AXIAL LOADS ON COLUMNS

		OVERTURNING-LINE 3				OVERTURNING-LINE 4			
LEVEL	HEIGHT	STORY SHEAR K	OTM 'K	ΣOTM 'K	AXIAL LOAD K	STORY SHEAR K	OTM 'K	ΣOTM 'K	AXIAL LOAD K
7	14.7'	24.5	360	360	6.7^K	11.7	172	172	3.2^K
6	14.0'	40.7	570	930	17.2	19.4	272	444	8.2
5	14.0'	54.2	759	1689	31.3	25.8	361	805	14.9
4	14.0'	67.8	949	2638	48.9	32.3	452	1257	23.3
3	14.0'	79.3	1110	3748	69.4	37.8	529	1786	33.1
2	21.0'	96.0	2016	5764	106.7	45.8	962	2748	50.9

WIND ANALYSIS

1ST STORY COLUMNS ON LINE 3 FOR BEND ABOUT MAJOR AXIS

LOADS ON COLUMNS - LINE 3 - 1ST STORY:

AXIAL: DEAD PLUS LIVE = 413^{K} - FROM ORIGINAL
CALCULATIONS
N-S OVERTURNING = 106.7^{K}

BENDING MOMENTS:

DEAD PLUS LIVE = $49^{'K}$ - FROM ORIGINAL CALCULATIONS
N-S WIND = $406^{'K}$ - PRORATED FROM ORIGINAL CALCULATIONS
E-W BENDING = $5.9^{'K}$ - DUE TO TORSION OF N-S WIND

STRESS RATIOS FOR AXIAL AND BENDING
(SEE SHEET 2-AM-E4 FOR ALLOWABLE STRESSES)(AISC 1.6-1a)

GRAVITY LOADS:

$$\frac{f_a}{F_a} = \frac{413/59.4}{15.96} = \frac{6.95}{15.96} = .436$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85(49\times12)/325}{\left(1-\frac{6.95}{38.31}\right)21.8} = \frac{1.53}{17.85} = \underline{.086}$$

$$\Sigma = .522$$

WIND LOADS:

$$\frac{f_a}{F_a} = \frac{106.7/59.4}{15.96} = \frac{1.80}{15.96} = .112$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85\times(406\times12)/325}{\left(1-\frac{8.75}{38.31}\right)21.8} = \frac{12.74}{16.82} = .757$$

$$\frac{C_{my} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85(5.9\times12)/124.4}{\left(1-\frac{8.75}{59.2}\right)24.75} = \frac{.48}{21.09} = \underline{.023}$$

$$\Sigma = .892$$

$$\left(\frac{f_w}{f_a}\right) \text{STRESS RATIO} = \frac{.892}{1.33-.522} = 1.10 > 1.0 \text{ CRITICAL}$$

WIND ANALYSIS

1ST STORY COLUMNS ON LINE 4 FOR BENDING ABOUT MINOR AXIS

LOADS ON COLUMNS - LINE 4 - 1ST STORY

AXIAL: DEAD PLUS LIVE = 413K - FROM ORIGINAL CALCULATIONS
N-S OVERTURNING = 50.9K

BENDING MOMENTS:

DEAD PLUS LIVE = 26'K - FROM ORIGINAL CALCULATIONS
N-S WIND = 194'K - PRORATED FROM ORIGINAL CALCULATONS
E-W BENDING = 4.4'K - DUE TO TORSION OF N-S WIND

STRESS RATIOS FOR AXIAL AND BENDING
(SEE SHEET 2-AM-E4 FOR ALLOWABLE STESSES)(AISC 16-1a)

GRAVITY LOADS:

$$\frac{f_a}{F_a} = \frac{413/59.4}{15.96} = \frac{6.95}{15.96} = .436$$

$$\frac{C_{mx} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85(26\times12)/124.4}{\left(1-\frac{6.95}{59.2}\right)24.75} = \frac{2.13}{21.84} = \underline{.098}$$

$$\Sigma = .534$$

WIND LOADS:

$$\frac{f_a}{F_a} = \frac{50.9/59.4}{15.96} = \frac{.86}{15.96} = .054$$

$$\frac{C_{my} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85\times(194\times12)/124.4}{\left(1-\frac{7.81}{59.2}\right)24.75} = \frac{15.91}{21.48} = .741$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85(4.4\times12)325}{\left(1-\frac{7.81}{38.31}\right)21.8} = \frac{.14}{17.86} = \underline{.008}$$

$$\Sigma = .749$$

$$\frac{f_w}{f_a} = \text{STRESS RATIO} = \frac{.749}{1.33-.534} = .94 < 1.0$$

WIND ANALYSIS

4TH STORY COLUMNS ON LINE 3 FOR BENDING ABOUT MAJOR AND MINOR AXES

COLUMN W14 x 150
A-7 STEEL $F_y = 33$ K.S.I.

$A = 44.1\,\square''$
$S_{xx} = 240''^3$ $r_{xx} = 6.37''$
$S_{yy} = 90.6''^3$ $r_{yy} = 3.99''$

COLUMN ALLOWABLE STRESS:

COLUMN LENGTH = 10' UNBRACED - BOTH DIRECTIONS
FROM 1969 AISC SPECIFICATIONS FIG. C1.8.2

FOR $K\ell/r_x$ $G = \dfrac{\frac{2540}{10}}{\frac{40200}{54}} = .12$ K = 1.0 EACH WAY

$K\ell/r_x = \dfrac{1 \times 10 \times 12}{6.37} = 19$ $K\ell/r_y = \dfrac{1 \times 10 \times 12}{3.99} = 30$

$$C_c = \sqrt{\frac{2\pi^2 E}{33}} = 131.6$$

$$F_a = \frac{\left[1 - \frac{30.0^2}{2 \times 131.6^2}\right] \times 33}{5/3 + \frac{3 \times 30}{8 \times 131.6} - \frac{30^3}{8 \times 136.6^3}} = \frac{29.57}{1.67 + .085 - .001} = 16.86 \text{ K.S.I.}$$

AISC 1.5.1.3.1

$$F'_{ex} = \frac{12\pi^2 E}{23\left(\frac{K\ell b}{rb}\right)^2} = \frac{12 \times \pi^2 \times 29 \times 10^6}{23 \times 19^2} = 400$$

$$F'_{ey} = \frac{12\pi^2 \times 29 \times 10^6}{23\,(30)^2} = 165.9$$

$F_{bx} = .66\,F_y = .66 \times 33 = 21.8$ K.S.I

FOR F_{by} - $\dfrac{b_f}{2t_f} < \dfrac{52.2}{\sqrt{F_y}}$ ∴ $F_{by} = .75\,F_y = .75\,F_y = .75 \times 33 = 24.75$ K.S.I.

WIND ANALYSIS

4TH STORY COLUMNS ON LINE 3 FOR BENDING ABOUT MAJOR AXIS

LOADS ON COLUMNS - LINE 3 - 4TH STORY:

AXIAL: DEAD PLUS LIVE = 235^K - FROM ORIGINAL
CALCULATIONS
N-S OVERTURNING = 31.3^K

BENDING:

DEAD PLUS LIVE = $87^{'K}$ - FROM ORIGINAL CALCULATIONS
N-S WIND = 135.4 - PRORATED FROM ORIGINAL CALCULATIONS
E-W BENDING = 3.8 - DUE TO TORSION OF N-S WIND

STRESS RATIOS FOR AXIAL AND BENDING
(SEE SHEET 2-AM-W.7 FOR ALLOWABLE STRESSES) (AISC 1.6-1a)

GRAVITY LOADS:

$$\frac{f_a}{F_a} = \frac{235/44.1}{16.86} = \frac{5.33}{16.86} \qquad = .316$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85(87 \times 12)/240}{\left(1-\frac{5.33}{400}\right)21.8} = \frac{3.7}{21.5} \qquad = \underline{.172}$$

$$\Sigma = .488$$

WIND LOADS:

$$\frac{f_a}{F_a} = \frac{31.3/44.1}{16.86} = \frac{.709}{16.86} \qquad = .042$$

$$\frac{C_{mx} f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}} = \frac{.85(145.8 \times 12)/240}{\left(1-\frac{6.04}{400}\right)21.8} = \frac{6.2}{21.5} \qquad = .288$$

$$\frac{C_{mx} f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}} = \frac{.85(3.8 \times 12)/90.6}{\left(1-\frac{6.04}{165.9}\right)24.75} = \frac{.48}{23.85} \qquad = \underline{.020}$$

$$\Sigma = .350$$

$$\text{STRESS RATIO} = \frac{.350}{1.33-.488} = .416$$

WIND ANALYSIS

EXTERIOR WALL STUDS FOR WIND FLEXURE

MAXIMUM HEIGHT OF STUDS AT PENTHOUSE FLOOR TO PENTHOUSE ROOF = 18'-3"

WIND FORCE. FROM ANSI A58.1-1972 - PRESSURE COEFFICIENT, $= C_p = -2.0$ AT CORNERS.
FROM TABLE 6 - EPOSURE B, 90 m.p.h. WIND,
$q_p = 27$ p.s.f. OVER 50' ABOVE GRADE.

THEREFORE $P = q_p\, C_p = 27 \times -2.0 = -54$ p.s.f.

STUDS - 6" - 16" GAGE WITH 1¼" FLANGES AT 16" ON CENTER, $F_y = 50$ K.S.I, $w = 1.0972$", $t = .0598$", $S_{xx} = .745''^3$ FROM MANUFACTURES CATALOGE.

STUD ALLOWABLE STRESSES:

IN AISI - SECTION 3.2 (b) $\quad w/t = \dfrac{1.0972}{.0598} = 18.37$

$$\frac{63.3}{\sqrt{F_y}} = 8.95 < 18.37 \qquad\qquad \frac{144}{\sqrt{F_y}} = 20.36 > 18.37$$

$$F_c = F_y \left[0.767 - (2.64/10^3)\ w/t\ \sqrt{F_y}\right]$$

$$F_c = 50\left[0.767 - \frac{2.64}{10^3} \times 18.37 \times \sqrt{50}\right] = 21{,}225 \text{ p.s.i.}$$

ALLOWABLE FLEXURAL STRESS = 21,225 × 1.33 = 28,230 p.s.i.

BENDING MOMENT DUE TO WIND PRESSURE P:

$$M = \frac{18.25^2}{8} \times 1.33\,(-54) = 2990 \text{ ft.-lbs}$$

$$\text{BENDING STRESS} = \frac{2990 \times 12}{.745} = 48{,}162 \text{ p.s.i.}$$

$$\text{STRESS RATIO} = \frac{48{,}162}{28{,}230} = 1.71 \quad \text{CRITICAL}$$

FACILITY NO. EXAMPLE 2

FORM AMC-1

APPROXIMATE ANALYTICAL METHOD
STRUCTURAL SYSTEMS - WIND RATING

BUILDING DESIGNATION:								
Exposure A,B,or C	Basic Wind Speed* V_1	Building Height	Effective Velocity Pressure q_F	Design Unit Pressure $q_F x1.4=P$ or $q_F x1.3=P$	Critical Elements		Critical Stress Ratio f_w/f_a	Basic Wind Speed Capacity $V_2 = V_1\sqrt{f_a/f_w}$
					Type	Location		
B	90	92' ±	13 TO 24	17 TO 31	COL.	1ST STORY	1.10	86

*See ANSI A58.1-72

f_w = Stress resulting from design pressures.

f_a = Allowable Material stress (x 1.33 where applicable)

NOTE: For rating of Structural Systems, use Form AME.

FORM AMC-1

FACILITY NO. EXAMPLE 2 FORM AMC-2

APPROXIMATE ANALYTICAL METHOD
OTHER LIFE HAZARDS - WIND RATING

TYPE OF RISK	CRITICAL STRESS RATIO	RATING
Glass Breakage*	------	COMPLIANCE
Glazing*	------	COMPLIANCE
Window Frame Anchorage	<1.0	GOOD
Wall Cladding Anchorage	<1.0	GOOD
Anchorage of Exterior Appendages	<1.0	GOOD
Exposed Walls	1.71	POOR
Canopies and Eaves	NONE	

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE*

TYPE	QUANTITY	DISTANCE
NONE		

*See Instructions for ratings.

CRITICAL STRESS RATIO	RATING
< 1.0	Good
1.0 to 1.5	Fair
> 1.5	Poor

E. Tornado Evaluation

The design forces for tornado for this example are direct horizontal wind pressures of 80 psf on the windward side and 50 psf on the leeward side. The uplift pressure on the roof and horizontal surfaces is 172 psf. The basis of this criteria for moderate resistance to tornadoes is explained in section 3.3D.

This building has a moment-resisting steel frame available to resist lateral forces. Calculations were available for earthquake and for a lesser wind pressure. Calculations are made for the tornado forces at each level. Original calculations show a distribution of horizontal forces to the individual bents based on relative rigidities. This same distribution (percentage of total load to a bent) is used for tornado forces.

The critical members as determined from the original wind computations were the first story columns on Line 4. This bent has columns oriented the weak way in resisting north-south lateral forces. A load diagram is shown for this bent and the corresponding bending moments in the columns are computed. The axial loads for overturning are also computed and the vertical loads are taken from the original calculations. These have been checked and found to be reasonably accurate. The columns are checked for combined stresses and the stress ratio computed. The allowable stresses are based on plastic design criteria.

The uplift on the roof could be critical since this exceeds the dead load. The roof trusses are braced only at mid-point and the capacity of the lower chords to take compression checked. One intermediate penthouse roof beam is also checked for uplift. For uplift on the total building it was found that sufficient dead loads are provided by the roof, sixth and fifth floors so that no net uplift occurs below the fifth floor.

The "Other Life Hazards" have not been calculated. The glazing, wall cladding, exterior appendages, window frames, and their anchorages are satisfactory for the usual heavy winds, but for positive and negative pressures more than twice that of most winds considerable damage should be expected. The horizontal portion of the projecting canopies at floor levels is supported by steel sections cantilevered from the main steel frame and probably would not become airborne.

The exterior steel studs of the penthouse would be expected to fail in a tornado since the stress ratio for wind analysis was high.

Reference is made to section 3.3D where these items are discussed in greater detail.

The metal deck anchorage is checked for uplift. There is no accepted value for tension on puddle welds of this type, but it appears reasonable to assume that this tension value would be approximately equal to the shear value.

DESIGN CRITERIA

LOAD CRITERIA (FROM ORIGINAL CALCULATIONS)

DEAD LOADS:

PENTHOUSE ROOF = 91 p.s.f.
PENTHOUSE FLOOR = 103 " INCLUDING MECHANICAL
7TH FLOOR = 102 "
MAIN ROOF = 75 "
2ND TO 6TH FLOOR = 73 "
LOW ROOF = 75 "

LIVE LOADS:

ROOFS = 20 p.s.f.
FLOORS = 50 p.s.f.

DEAD AND LIVE LOADS AND MOMENTS IN COLUMNS ARE FROM ORIGINAL CALCULATIONS

TORNADO CRITERIA (SEE SECTION 3.3D)

HORIZONTAL WIND PRESSURE:

WINDWARD SIDE = 80 p.s.f.
LEEWARD SIDE = 50 p.s.f

UPLIFT WIND PRESSURE = 172 p.s.f.

STEEL DESIGN CRITERIA

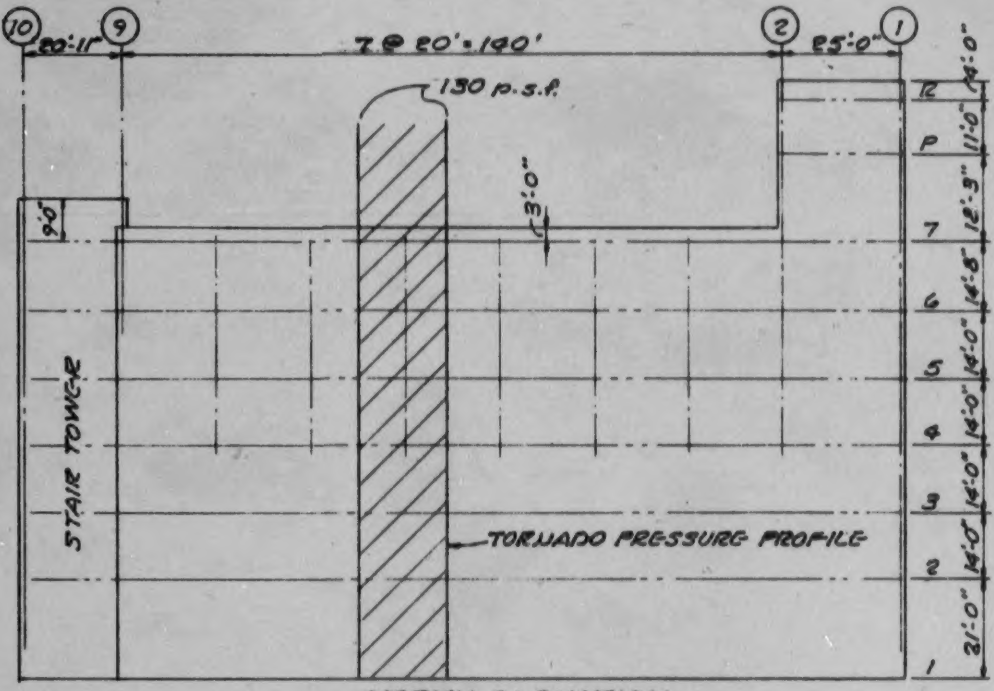
STRUCTURAL STEEL - ASTM A-7, F_y = 33 k.s.i., 1969 AISC SPECIFICATIONS PART 2

MEMBERS TO BE CHECKED

FIRST STORY COLUMNS ON LINE 4 WHICH HAVE THE HIGHEST STRESS RATIOS INDICATED ON THE WIND ANALYSIS WILL BE CHECKED.

TORNADO ANALYSIS

TORNADO LATERAL PRESSURE DISTRIBUTION


10
9
2
1
20'-11"
7 @ 20' = 140'
25'-0"
130 p.s.f.
3'-0"
9'-0"
STAIR TOWER
TORNADO PRESSURE PROFILE
R
P
7
6
5
4
3
2
1
14'-0"
11'-0"
12'-3"
14'-8"
14'-0"
14'-0"
14'-0"
14'-0"
21'-0"

NORTH ELEVATION

TORNADO FORCES AND SHEARS AT EACH LEVEL

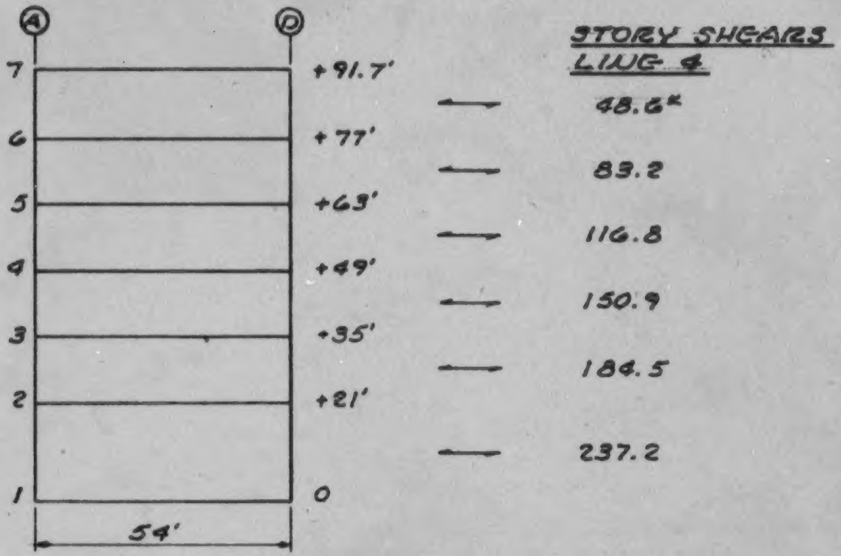
N-S TORNADO

LEVEL	HEIGHT	PRESS. p.s.f.	TRIB. HEIGHT	LENGTH	TORNADO FORCE	STORY SHEAR
R	121	130	9.5	27	33,345#	33.3k
P	110	130	14.65	27	51,422	84.8
7	91.7	130	16.5 10.35 16.35	27 140 22	57,915 188,370 46,761	377.8
6	77	130	14.35	188	350,714	228.5
5	63	130	14	188	342,160	1,070.7
4	49	130	14	188	342,160	1,412.8
3	35	130	14	188	342,160	1,755.0
2	21	130	17.5	188	427,700	2,182.7

TORNADO ANALYSIS

DISTRIBUTION OF SHEARS TO FRAME ON LINE 4

TO DETERMINE THE SHEARS TO FRAME 4 DUE TO THE TRANSVERSE (N-S) TORNADO LOADS, THE STORY SHEARS ARE DISTRIBUTED TO THE FRAME IN PROPORTION TO THEIR RELATIVE STIFFNESSES. THE STORY SHEARS, INCLUDING THE EFFECTS OF TORSION, HAVE BEEN PRORATED USING THE RALATIVE STIFFNESSES OF THE FRAMES AS SHOWN IN THE ORIGINAL CALCULATIONS. FOR EXAMPLE ON LINE 4 AT 7TH LEVEL; ORIGINAL SHEAR ON LINE 4 WAS 5.4K, ORIGINAL STORY SHEAR WAS 42K. NEW STORY SHEAR = 377.8K (SHEET 2-AM-T2) ∴ NEW LINE 4 SHEAR = $\frac{5.4}{42} \times 377.8 = 48.6^{K}$



OVERTURNING MOMENTS AND AXIAL LOAD ON COLUMNS

LEVEL	HEIGHT	STORY SHEAR K	OTM 'K	ΣOTM 'K	AXIAL LOAL K.
7	14.7'	48.6K	714.4'K	714.4'K	13.2K
6	14.0	83.2	1164.8	1879.2	34.8
5	14.0	116.8	1635.2	3514.4	65.1
4	14.0	150.9	2112.6	5627.0	104.2
3	14.0	184.5	2583.0	8210.0	152.0
2	21.0	237.2	4981.2	13191.2	244.3

2-AM-T4

TORNADO ANALYSIS

1ST STORY COLUMNS ON LING 4 FOR BENGING ABOUT MINOR AXIS.

COLUMN W14 x 202
A-7 STEEL $F_y = 33$ K.S.I.

$A = 59.39^{\square''}$
$S_{xx} = 324.9''^3$ $r_{xx} = 6.54''$
$S_{yy} = 124.4''^3$ $r_{yy} = 4.06''$

COLUMN ALLOWABLE STRESSES:

COLUMN LENGTH = 17' UNBRACED - BOTH DIRECTIONS
FROM 1969 AISC SPECIFICATIONS FIG. C1.8.2

$$\text{FOR } {}^{K\ell}/r_x \; G = \frac{\Sigma \frac{I_c}{L_c}}{\Sigma \frac{I_g}{L_g}} = \frac{\frac{2538}{17}}{\frac{40200}{54}} = .20 \qquad \text{FOR } {}^{K\ell}/r_y \; G = \frac{\frac{980}{17}}{\frac{40200}{20}} = .02$$

K = 2.0
X = AXIS

K = 1.0
Y = AXIS

$$K\ell/r_{xx} = \frac{2 \times 17 \times 12}{6.54} = 62.4 \qquad K\ell/r_{yy} = \frac{1 \times 17 \times 12}{4.06} = 50.2$$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = 131.6$$

$$F_a = \frac{\left[1 - \frac{(K\ell/r)^2}{2C_c^2}\right] F_y}{5/3 + \frac{3(K\ell/r)}{8C_c} - \frac{(K\ell/r)^3}{8C_c^3}} = \frac{\left[1 - \frac{(62.4)}{2 \times 131.6^2}\right] \times 33}{5/3 + \frac{3 \times 62.4}{8 \times 131} - \frac{(62.4)^3}{8 \times 131.6^3}} = \frac{29.29}{1.67 + .178 - .01}$$

$F_a = 15.76$ K.S.I.

$$F'_{ex} = \frac{12\pi^2 E}{23\left(\frac{K\ell_b}{r_b}\right)^2} = \frac{12 \times \pi^2 \times 29 \times 10^6}{23 \times 62.4^{-2}} = 38.31 \text{ K.S.I.}$$

$$F'_{ey} = \frac{12\pi^2 E}{23 \times 50.2^2} = 59.2 \text{ K.S.I.}$$

FOR PLASTIC DESIGN:

$M_{px} = Z_x \times F_y = 391 \times 33 = 12{,}903''^{K}$ $M_{py} = 198 \times 33 = 6534''^{K}$

2-AM-T5

TORNADO ANALYSIS

1ST STORY COLUMNS ON LINE 4 FOR BENDING ABOUT MINOR AXIS

LOADS ON COLUMNS - LINE 4 - 1ST STORY

AXIAL: DEAD PLUS LIVE = 413K - FROM ORIGINAL CALCULATIONS
N-S OVERTURNING = 244.3K

BENDING MOMENTS:

DEAD PLUS LIVE = 26'K - FROM ORIGINAL CALCULATIONS
N-S TORNADO = 1034'K - PRORATED FROM ORIGINAL CALCULATIONS
E-W BENDING = 23.4'K - DUE TO TORSION OF N-S TORNADO

STRESS RATIOS FOR AXIAL AND BENDING
(SEE SHEET 2-AM-T4 FOR ALLOWABLE STRESSES)

$$P_{cr} = 1.7 A F_a = 1.7 \times 59.39 \times 15.96 = 1611.4^K \text{ (AISC 2.4-1)}$$

$$\frac{P}{P_{cr}} + \frac{C_m M_x}{\left(1-\frac{P}{P_e}\right) M_{mx}} + \frac{C_m M_y}{\left(1-\frac{P}{P_e}\right) M_{my}} \leq 1.0 \text{ (AISC 2.4-1)}$$

$$M_{mx} = \left[1.07 - \frac{(l/r_y)\sqrt{F_y}}{3160}\right] M_{px} = \left[1.07 - \frac{\left(\frac{17 \times 72}{4.06}\right)\sqrt{33}}{3160}\right] 12{,}903 = 12627''^K$$

$$M_{my} = \left[1.07 - \frac{\left(\frac{17 \times 12}{6.54}\right)\sqrt{33}}{3160}\right] \times 6534 = 6620 > 6534$$

$$P_{ex} = \left({}^{23}/_{12}\right) A F'_{ex} = {}^{23}/_{12} \times 59.39 \times 38.31 = 4361^K$$

$$P_{ey} = {}^{23}/_{12} \times 59.39 \times 59.2 = 6739^K$$

$$\therefore \frac{413 + 244.3}{1611.4} + \frac{.85(23.4 \times 12)}{\left(1-\frac{657.3}{4361}\right)12{,}627} + \frac{.85(26+1034) \times 12}{\left(1-\frac{657.3}{6739}\right)6534} =$$

$$= .407 + .022 + 1.834 \frac{f_r}{f_a} = 2.263$$

2.263 > 1.0 CRITICAL ABOVE PLASTIC CAPACITY

2-AM-T6

TORNADO ANALYSIS

TORNADO UPLIFT ON ROOF

TYPICAL PENTHOUSE ROOF BEAM: W14×30

SPAN = 25' TRIBUTARY WIDTH = 7'-1" DEAD PLUS LIVE = 91 p.s.f.
UPLIFT LOAD = 172 p.s.f. NET UPLIFT = 172 - 91 = 81 p.s.f.

MOMENT = $\frac{25'^2}{8} \times .081 \times 12 = 44.9'^{K}$ STRESS = $\frac{44.9 \times 12}{41.8} = 12.9$ K.S.I.

ALLOWABLE $F_b = \frac{12 \times 10^3 C_b}{ld/A_f} = \frac{12 \times 10^3 \times 1}{25 \times 12 \times 5.37} = 7.55$ K.S.I.

FOR PLASTIC CAPACITY = $1.7 F_b = 1.7 \times 7.55 = 12.84$ K.S.I. (AISC 2.1)

STRESS RATIO = $\frac{12.9}{12.84} = 1.005$

TYPICAL ROOF TRUSS:

SPAN = 54' TRIBUTARY WIDTH = 20' DEAD LOAD = 75 p.s.f.
NET UPLIFT = 172 - 75 = 97 p.s.f. TRUSS DEPTH = 4'-6"

TRUSS MOMENT = $\frac{54'^2}{8} \times .097 \times 20 = 707'^{K}$ LOWER CHORD FORCE = $\frac{707}{4.5} = 157^{K}$

TRUSS LOWER CHORD 2 ⅃L 6×6×1, $A = 22.0$ $r_{yy} = 2.73"$ BRACED @ MIDSPAN
$L/r_y = \frac{27 \times 12}{2.73} = 118.7$ (AISC 1.5.1.3.1) $C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = 131.7$

$$F_a = \frac{\left[1 - \frac{118.7}{2 \times 131.7^2}\right] \times 33}{5/3 + \frac{3 \times 118.7}{8 \times 131.7} - \frac{118.7^3}{8 \times 131.7^3}} = 10.09 \text{ K.S.I.}$$

PLASTIC CAPACITY = $1.7 \times 22 \times 10.09 = 377.4^{K}$

STRESS RATIO = $\frac{157}{377.4} = .416$

UPLIFT ON TOTAL BUILDING

THE DEAD LOADS AVAILABLE IN THE ROOF, 6TH AND 5TH FLOORS EQUALS 75 + 73 + 73 = 221 p.s.f. WHICH EXCEEDS THE TORNADO UPLIFT LOAD OF 172 p.s.f. ON THE ROOF. THERE WILL BE NO NET UPLIFT FORCES BELOW THE 5TH FLOOR.

TORNADO ANALYSIS

UPLIFT ON STEEL ROOF DECK

MAXIMUM SPAN = 7'-1" DEAD LOAD = 91 p.s.f.

UPLIFT LOAD = 172 p.s.f. - NET UPLIFT = 172 - 91 = 81 p.s.f.

SINCE STEEL DECK WAS ORIGINALLY DESIGNED FOR 91 p.s.f. DOWNWARD VERTICAL LOAD, IT IS THEREFORE GOOD FOR 81 p.s.f. UPWARD LOAD. ∴ STRESS RATIO < 1.0 IN FLEXURE.

CHECKING PUDDLE WELD ATTACHMENT:

PLANS CALL FOR 3 PUDDLE PER 2' WIDE SHEET.

TRIBUTARY UPLIFT LOAD PER WELD $= \frac{7.1 \times 81 \times 2}{3} = 383^{\#}$

ASSUME UPLIFT CAPACITY OF PUDDLE WELDS EQUAL THEIR SHEAR CAPACITY. FROM TRISERVICE MANUAL, Eq. 5-6-1

ULTIMATE CAPACITY $= 46000t \times \underbrace{2}_{\text{FACTOR FOR ULTIMATE CAPACITY.}} = 4420^{\#}$

$t = .048"$ (18 GAGE)

∴ STRESS RATIO $= \frac{383}{4420} = .086$ NOT CRITICAL

FACILITY NO. EXAMPLE 2 FORM AMD-1

APPROXIMATE ANALYTICAL METHOD
RATING FORM - TORNADOES

SYSTEMS CRITICAL STRESS RATIOS*

SYSTEM	f_T/f_a **
Roof	TRUSS-4 WT. BM. 1.0
Roof Anchorage	< 1.0
Floor	NOT CHECKED
Floor Anchorage	" "
Vertical Resisting Element	2.8
Anchorage to Footings	< 1.0
Footings	< 1.0

*Use highest Critical Stress Ratio.
For Structural Systems Rating - Tornado, see Form AME.

**f_T = Capacity required to resist tornado forces.
f_a = Capacity based on design criteria.

FACILITY NO. EXAMPLE 2 FORM AMD-2

APPROXIMATE ANALYTICAL METHOD

OTHER LIFE HAZARDS - TORNADO RATING - NOT COMPUTED

TYPE OF RISK	CRITICAL STRESS RATIO	RATING
Glass Breakage*		
Glazing*		
Window Frame Anchorage		
Wall Cladding Anchorage		
Anchorage of Exterior Appendages		
Exposed Walls		
Canopies & Eaves		

POTENTIAL MISSILES FROM OUTSIDE OF STRUCTURE*

TYPE	QUANTITY	DISTANCE

*See Instructions for ratings.

CRITICAL STRESS RATIO	RATING
< 2.0	Good
2.0 to 3.0	Fair
> 3.0	Poor

F. Resume

Earthquake

This building has been evaluated for an earthquake of MMI 9.5 which is quite severe. It rates "Fair" in its capacity to resist this earthquake and would rate "Good" for earthquakes of lesser intensity.

The Stair and Exit Enclosures rate "Good" for earthquake. Except for the unbraced ceilings and light fixtures, the Other Life Hazards are rated "Good."

Wind

This building has been evaluated for a Basic Wind Speed of 90 mph with Exposure "B." The Structural Systems rating is "Fair." The Other Life Hazards are rated "Good" except the high steel stud penthouse walls which are rated "Fair." No potential wind blown missiles were noted near this site.

Tornado

This building has been evaluated for moderate resistance to Tornado using an uplift force of 172 psf on the roof and a direct horizontal force of 130 psf on the building as a whole. Ultimate capacities were used for f_a values. The highest stress ratio was found to be in the first story column on Line 4. The f_T/f_a ratio is 2.3 and the rating for Tornado is "Fair."

Other Life Hazards from Tornado were not calculated in this example, but from experience and judgment it is probable that a good deal of glass would be lost and that there would be considerable damage to exterior metal stud and plaster walls and the exterior appendages.

It is noted that the Tornado rating of "Fair" is the same as that for Wind, even though the Tornado forces are much greater than the Wind forces. This is because consideration is given to the short duration of Tornado forces and the probability that Tornado forces will not act on all of the building at the same time with the same intensity.

The calculations show that the metal deck will not be stripped off due to the Tornado suction. However, little is known about the bond of concrete to metal decks and it is probable that some of the concrete fill would be stripped from the metal deck.

The attachment of the roofing felts to the concrete could not be determined from the plans and specifications. If not unusually well mopped down, it is possible that the roofing would be stripped from the concrete topping if subjected to suction forces from a tornado.

FACILITY NO. EXAMPLE 2

FORM AME

APPROXIMATE ANALYTICAL METHOD
CRITICAL STRESS RATIOS - STRUCTURAL SYSTEMS

	Critical Stress Ratio	Rating
Earthquake	1.06	FAIR
Wind	1.1	FAIR
Tornado	2.3	FAIR

RATING OF CRITICAL STRESS RATIOS

Critical Stress Ratio	Earthquake or Wind	Tornado
Less than 1.0	Good	Good
1 to 1.5	Fair	Good
1.5 to 2.0	Poor	Good
2.0 to 3.0	Very Poor	Fair
3.0 to 4.0	Very Poor	Poor
Over 4.0	Very Poor	Very Poor

D.4 EXAMPLE 3

A. GENERAL DISCUSSION

This example is a building simulation to demonstrate in the most simple fashion the manner in which buildings having irregularities in dynamic characteristics will be analyzed for earthquake resistance using the Approximate Analytical Evaluation Method. A portion of a long 4-story building is assumed to have moment-resistant frames in both directions. The building is also assumed to have shear walls as a primary shear resisting system above the second floor in the transverse direction.

In order to determine the equivalent size of force input to evaluate the building, it is assumed that the 1973 UBC base shear factor $C = \frac{.05}{\sqrt[3]{T}}$ for a building with uniform dynamic characteristics can be approximated by a single degree-of-freedom spectrum of $S_{ma} = \frac{.06g}{\sqrt[4]{Tm}} = 0.10g$. In other words, if the modal responses of a dynamically uniform building to the empirical single degree-of-freedom spectra are combined by the method of the square root of the sum of the squares, the resulting multi-degree of freedom response will be approximately that specified in 1973 UBC. If other spectra are determined as being appropriate for comparison with code design resistances (see section 3.4), these may also be used. The example is carried out to the point of indicating the shears and moments to be used for evaluation.

EXAMPLE 3

DESIGN CRITERIA

1) SEISMIC ZONE 1
   $Z = 1.0$

2) MAXIMUM ALLOWABLE
   DRIFT = .003

3) LOADING

   ROOF L.L = 20 #/□'
   FLOOR L.L = 50 #/□'

   8" SHEAR WALL – 100 #/□'

   ROOF D.L

ROOF	70 #/□'
OVERHANG	50 #/□'

   FLOOR D.L

FLOOR	90 #/□'
OVERHANG	60 #/□'
RAILING	100 #/FT.

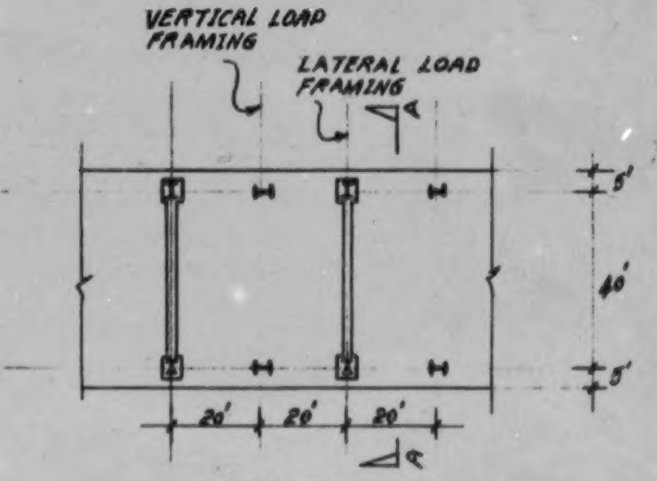
4) PROPERTIES OF MATERIALS

   CONCRETE

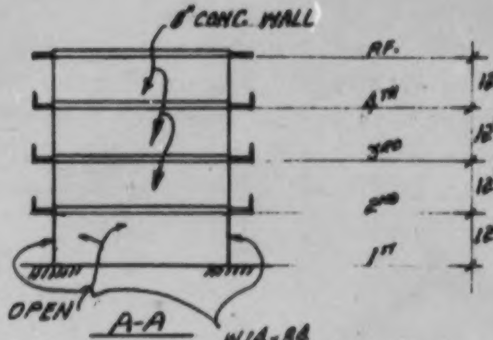
   $f'_c = 4000$ PSI ; $E_c = 3.64 \times 10^6$ PSI

   STRUCTURAL STEEL

   $F_Y = 36000$ PSI ; $E_S = 29 \times 10^6$ PSI


VERTICAL LOAD FRAMING
LATERAL LOAD FRAMING
A
5'
40'
5'
20'
20'
20'
A

PLAN


8" CONC. WALL
RF.
4TH
3RD
2ND
1ST
12'
12'
12'
12'
OPEN
W14×84
AREA = 24.7 IN²
$I_x = 928$ IN⁴ $S_x = 131$ IN³
$r_x = 6.13$ IN $r_Y = 3.02$

A-A

PROCEDURE

1) FIND MASS [m] MATRIX (UNITS – K/IN/SEC²)

$$w_R = (70\cdot40\cdot40 + 50\cdot2\cdot40\cdot5 + 100\cdot40\cdot6)/1000 = 156^k$$

$$w_4 = w_3 = (90\cdot40\cdot40 + 60\cdot2\cdot40\cdot5 + 100\cdot40\cdot12 + 100\cdot2\cdot40)/1000 = 224^k$$

$$w_2 = (90\cdot40\cdot40 + 60\cdot2\cdot40\cdot5 + 100\cdot40\cdot6 + 100\cdot2\cdot40)/1000 = 200^k$$

WHERE w – TRIBUTARY DEAD LOAD TO LATERAL LOAD FRAMING.
MASS: $m = w/g$ – ($g = 386.4$ IN/SEC²)

$$[m]_{N\times N} = \frac{1}{386.4}\begin{bmatrix}156 & & & \\ & 224 & & \\ & & 224 & \\ & & & 200\end{bmatrix}_{4\times4} = \begin{bmatrix}.40373 & & & \\ & .57971 & & \\ & & .57971 & \\ & & & .51760\end{bmatrix}_{4\times4}$$

N : NO. OF STORIES

2) FIND FLEXIBILITY [a] MATRIX (h - HEIGHT OF WALL)

a) DEFLECTION OF SHEAR WALL FOR $P = 1^k$ (NEGLECT COLUMN AXIAL DEFORMATIONS)

$$\Delta = \frac{Ph^3}{3EI} + \frac{1.2Ph}{.4EA} = \frac{1\cdot 12^3\cdot 12^3}{3\cdot 3.64\cdot 10^3\cdot \frac{8\cdot(40\cdot 12)^3}{12}} + \frac{1.2\cdot 1\cdot (12\cdot 12)}{.4\cdot 3.64\cdot 10^3\cdot (8\cdot 40\cdot 12)}$$

$$= .0000037 + .0000309 = .0000346^{IN}$$

b) DEFLECTION OF 1ST STORY FOR $P = 1^k$ (ASSUME 2 COLUMNS AS GUIDED CANTILEVERS)

$$\Delta = \frac{2Ph^3}{3EI} = \frac{2\times(1/2)\times(12/2)^3\times 12^3}{3\times 29000\times 928} = .0046230^{IN}$$

c) FLEXIBILITY MATRIX ASSUMING NO ROTATION AT FLOORS.

$$[a]_{N\times N} = \begin{bmatrix}.0046230 & .0046230 & .0046230 & .0046230\\ .0046230 & .0046576 & .0046576 & .0046576\\ .0046230 & .0046576 & .0046922 & .0046922\\ .0046230 & .0046576 & .0046922 & .0047268\end{bmatrix}_{4\times4}$$

3) ASSUME SHAPES [ϕ] FOR DESIRED MODES (NORMALIZED AT TOP FLOOR)

$$[\Phi]_{N\times K} = \begin{bmatrix}.990 & 1.026 & 1.099 & 1.210\\ .995 & .471 & -.850 & -2.276\\ .998 & -.395 & -.968 & 2.191\\ 1.000 & -1.000 & 1.000 & -1.000\end{bmatrix}_{4\times4}$$

K: NO. OF DESIRED MODES

4) CALCULATE GENERALIZED MASS [m] MATRIX

$$[m]_{K\times K} = [\Phi]^T_{K\times N}\,[m]_{N\times N}\,[\Phi]_{N\times K}$$

5) CALCULATE GENERALIZED STIFFNESS $[k]$ MATRIX

$$[k]_{R \times R} = \omega^4 [G]_{R \times R} = \omega^4 [\phi]^T_{R \times N} [m]_{N \times N} [a]_{N \times N} [m]_{N \times N} [\phi]_{N \times R}$$

ω : FREQUENCY

6) GENERALIZED EQUATION OF MOTION

$$[m]\{q\} = \omega^2 [G]\{q\}$$

q: NORMAL COORDINATES

WHICH IS PREMULTIPLIED BY $[m]^{-1}$ AND REARRANGED TO

$$\left([D] - \frac{1}{\omega^2}[I]\right)\{q\} = 0 \quad -- \qquad \text{WHERE } [D] = [m]^{-1}[G]$$

7) SOLVE EIGENVALUE PROBLEM FOR NATURAL FREQUENCIES AND THUS PERIODS AND MODE SHAPES

STEPS 4 THRU 7 HAVE BEEN CARRIED OUT BY A COMPUTER PROGRAM FOR THIS EXAMPLE.

```
EXAMPLE      4
  PROGRAM FRESH
  FREQUENCY AND MODE SHAPES BY INFLUENCE COEFF.

  INPUT DATA
  ------


 DIAGONAL MASS MATRIX
.40373   .57971   .57971   .5176
 FLEXIBILITY MATRIX
.4623E-02   .4623E-02   .4623E-02   .4623E-02
.4623E-02   .46576E-02      .46576E-02      .46476E-02
.4623E-02   .46576E-02      .46922E-02      .46922E-02
.4623E-02   .46576E-02      .46922E-02      .47268E-02

 ASSUMED SHAPES FOR DESIRED MODES
.99   1.026     1.099     1.21
.995      .471     -.85  -2.276
.998     -.395     -.968      2.191
1    -1      1    -1
```

3-E4

```
OUTPUT
------

 MODE NO.     1
FREQUENCY=     10.1583   RAD/SEC.
 NORMAL COORDINATES
   19 ITERATIONS    20 ITERATIONS
   1.0000000E+00    1.0000000E+00
   2.0085347E-15    2.0085347E-15
   1.1086341E-15    1.1086341E-15
   2.2389059E-16    2.2389059E-16
 MODE SHAPE
.98826599
.99423791
.99815195
1

 <<<<<<>>>>>>


 MODE NO.     2
FREQUENCY=    188.7649   RAD/SEC.
 NORMAL COORDINATES
   19 ITERATIONS    20 ITERATIONS
   4.2399100E-13    4.2399100E-13
   1.0000000E+00    1.0000000E+00
   1.8948193E-13    1.8948193E-13
   1.4337807E-14    1.4337807E-14
 MODE SHAPE
1.0493652
.53489924
-.36186431
-1

 <<<<<<>>>>>>

 MODE NO.     3
FREQUENCY=    336.9828   RAD/SEC.
 NORMAL COORDINATES
   19 ITERATIONS    20 ITERATIONS
   1.2473371E-07    1.2474247E-07
   3.6632386E-07    3.6634957E-07
   1.0000000E+00    1.0000000E+00
   3.2633389E-06    3.2635679E-06
 MODE SHAPE
 1.2316926
-.71291092
-1.0336953
 1

 <<<<<<>>>>>>
```

3-E5

```
 MODE NO.       4
FREQUENCY=     422.0068   RAD/SEC.
 NORMAL COORDINATES
    19 ITERATIONS      20 ITERATIONS
    3.82244L2E-02      3.8224412E-02
    1.1225374E-01      1.1225374E-01
    1.4099453E-01      1.4099453E-01
    1.0000000E+00      1.0000000E+00
 MODE SHAPE
 1.6497059
-2.4419968
 2.1894015
-1

 <<<<<<>>>>>>

RUN COMPLETE.
```

FROM COMPUTER OUTPUT THE FREQUENCIES (radians/sec) are:

$f_1 = 10.1583$ $f_2 = 188.7649$ $f_3 = 336.9828$ $f_4 = 422.0068$

$$\therefore\ T_1 = \frac{2\pi}{f_1} = .6186^{\text{sec.}}\quad T_2 = \frac{2\pi}{f_2} = .0333^{\text{sec.}}\quad T_3 = \frac{2\pi}{f_3} = .0186^{\text{sec.}}\quad T_4 = \frac{2\pi}{f_4} = .0149^{\text{sec.}}$$

8) SPECTRAL MODAL ANALYSIS

$$V_m = \frac{W_m}{g} . S_{ma} \quad ; \quad W_m = \frac{(\Sigma\, \phi_{mx}\, w_x)^2}{\Sigma\, \phi^2_{mx}\, w_x} \quad ; \quad S_{ma} = \frac{.06}{\sqrt[4]{T_m}} . g \leq .10g$$

$$F_{mx} = \frac{V_m w_x \phi_x}{\Sigma\, w_x \phi_x}$$

WHERE

V_m = BASE SHEAR FOR MODE m.

W_m = WEIGHT OF STRUCTURE EQUIVALENT TO A SINGLE MASS OSCILLATOR FOR MODE m.

w_x = WEIGHT OF STRUCTURE AT LEVEL X.

ϕ_{mx} = VALUE OF MODE SHAPE FOR MODE m AT LEVEL X.

S_{ma} = SPECTRAL ACCELERATION FOR MODE m.

F_{mx} = FORCE ON THE STRUCTURE FOR MODE m AT LEVEL X.

T_m = NATURAL PERIOD IN MODE m.

$$S_{1a} = \frac{.06}{4\sqrt{.6186}} \times 32.2 \times 12 = 26.14^{\text{IN/SEC}^2}$$

$$S_{2a} = \frac{.06}{4\sqrt{.0383}} \times 32.2 \times 12 = 54.27 > .10g(38.64);\ \therefore S_{2a} = 38.64^{\text{IN/SEC}^2}$$

SIMILARLY

$$S_{3a} = S_{4a} = 38.64^{\text{IN/SEC}^2}$$

STEP 8 HAS BEEN CARRIED OUT BY A COMPUTER PROGRAM FOR THIS EXAMPLE.

```
EXAMPLE      4

 FLEXIBILITY MATRIX

      4.62300E-03        4.62300E-03        4.62300E-03        4.62300E-03
      4.62300E-03        4.65760E-03        4.65760E-03        4.65760E-03
      4.62300E-03        4.65760E-03        4.69220E-03        4.69220E-03
      4.62300E-03        4.65760E-03        4.69220E-03        4.72680E-03

>>RESPONSE TO MODE NO.  1

  SPECTRAL ACCELERATION      26.140 IN./SEC./SEC.

LEVEL   HX(IN)  WX(K)       PX        FX(K)       VX(K)    OTM(IN-K)  DEFL(IN)
  4        144    156    1.000         10.6        10.6        1529     .2543
  3        144    224     .998         15.2        25.8        5248     .2540
  2        144    224     .994         15.2        41.0       11149     .2531
  1        144    200     .988         13.4        54.4       18988     .2516
```

3-E7

```
>>RESPONSE TO MODE NO.  2

  SPECTRAL ACCELERATION     38.640 IN./SEC./SEC.

LEVEL  HX(IN)  WX(K)        PX       FX(K)       VX(K)   OTM(IN-K)  DEFL(IN)
  4       144    156    -1.000        -3.1        -3.1        -443     .0081
  3       144    224     -.362        -1.6        -4.7       -1117     .0082
  2       144    224      .535         2.4        -2.3       -1450     .0084
  1       144    200     1.049         4.1         1.8       -1187     .0085

>>RESPONSE TO MODE NO.  3

  SPECTRAL ACCELERATION     38.640 IN./SEC./SEC.

LEVEL  HX(IN)  WX(K)        PX       FX(K)       VX(K)   OTM(IN-K)  DEFL(IN)
  4       144    156     1.000          .2          .2          31     .0001
  3       144    224    -1.034         -.3         -.1          16     .0001
  2       144    224     -.713         -.2         -.3         -30     .0001
  1       144    200     1.232          .3          .0         -28     .0001


>>RESPONSE TO MODE NO.  4

  SPECTRAL ACCELERATION     38.640 IN./SEC./SEC.

LEVEL  HX(IN)  WX(K)        PX       FX(K)       VX(K)   OTM(IN-K)  DEFL(IN)
  4       144    156    -1.000        -.6         -.6          -85     .0020
  3       144    224     2.189        1.9         1.3           97     .0021
  2       144    224    -2.442       -2.1         -.8          -19     .0020
  1       144    200     1.650        1.2          .4           45     .0020

  --SUMMARY--

 LEVEL  ROOT OF SUM OF THE SQUARES          ABS SUM OF TWO LARGEST MODES
 NO    SHEAR(K)  OTM(IN-K)  DEFL(IN)   SHEAR(K)  OTM(IN-K)  DEFL(IN)

  4        11.1       1594     .2545       13.7       1972     .2624
  3        26.3       5366     .2541       30.5       6365     .2622
  2        41.1      11243     .2532       43.3      12600     .2614
  1        54.5      19025     .2518       56.3      20175     .2601

RUN COMPLETE.
```

3-EB

COMPUTER OUTPUT NOTATIONS

HX = FLOOR HEIGHT
WX = TRIBUTARY FLOOR WEIGHT
PX = MODE SHAPE (ϕ_{mx})
FX = LATERAL FORCE APPLIED TO THE FLOOR (F_{mx})
VX = TOTAL LATERAL SHEAR AT THE FLOOR
OTM = TOTAL OVERTURNING MOMENT AT THE FLOOR
DEFL = DEFLECTION OF THE FLOOR WITH RESPECT TO THE BASE

9) CHECK SHEAR WALL

$$V_u = .75 \times 1.7 \times 1.1 \times (41.1) = 57.64^K$$

SHEAR STRESS IN 2ND FLOOR WALL

$$v_u = \frac{V_u}{\phi h d}$$

$$= \frac{57.64 \times 1000}{.85 \times 8 \times (.8 \times 40 \times 12)}$$

$$= 22 \text{ PSI (NOT CRITICAL)}$$

10) CHECK W14x84 COLUMN

AXIAL LOADS IN COLUMNS

D.L

RF. (70x20x20+50x5x20+100x20x6)/1000 $= 45^K$

4^{TH} (90x20x20+60x5x20+100x20x12+100x20)/1000 $= 68^K$

3^{RD} " " " $= 68^K$

2^{ND} (90x20x20+60x5x20+100x20x6+100x20)/1000 $= 56^K$

$\Sigma\ 237^K$

L.L (USING REDUCED L.L FOR, ROOF $12^{\#/\square'}$ & FLOOR $20^{\#/\square'}$)

ROOF 12(20x20+20x5)/1000 $= 6^K$

FLOORS (4^{TH}, 3^{RD}, 2^{ND}) 3x20(20x20+20x5) $= 30^K$

$\Sigma\ 36^K$

OVERTURNING (SEISMIC)

$$= \frac{19025}{40 \times 12} = 39.6^K$$

$$(f_a)_{D.L+L.L} = \frac{237+36}{24.7} = 11.05 \text{ KSI} \qquad (f_a)_{SEIS.} = \frac{39.6}{24.7} = 1.60 \text{ KSI}$$

$$M_{SEIS.} = \left(\frac{54.5}{2}\right) \times 6 \times 12 = 1962^{in\text{-}K} \qquad (f_b)_{SEIS.} = \frac{1962}{131} = 14.98 \text{ KSI}$$

ALLOWABLE STRESSES FOR W14x84 ($L_c = 12.7'$)

$$\frac{Kl}{r_Y} = \frac{1.0 \times 10 \times 12}{3.02} = 39.7 \ ; \ \frac{Kl}{r_x} = \frac{1.0 \times 10 \times 12}{6.13} = 19.6$$

$F_a = 19.21$ KSI ; $F'_{ex} = 388.8$ KSI ; $F_b = 24$ KSI

3-E10

a) COMBINED STRESS

$$= \frac{11.05}{19.21} + \frac{1.60}{19.21} + \frac{.85 \times 14.98}{\left(1 - \frac{12.66}{388.8}\right)24} = .575 + .083 + .548$$

$$= 1.206 < 1.383 \quad \text{O.K}$$

b) CRITICAL STRESS RATIO

$$= \frac{.083 + .546}{1.333 - .575} = \underline{.832}$$

II) 1st STORY DRIFT (ASSUME 2 COLUMNS AS GUIDED CANTILEVERS)

$$\text{DRIFT} = \frac{2 \times Pl^3/3EI}{12 \times 12}$$

$$= \frac{2 \times \left(\frac{54.5}{2}\right) \times 6^3 \times 12^3 / 3 \times 29000 \times 928}{12 \times 12} = .0017 < .003 \quad \text{O.K}$$

D.5 BUILDINGS USED TO DEMONSTRATE THE DETAILED ANALYTICAL EVALUATION METHOD

A. Earthquake Damage Evaluation Buildings

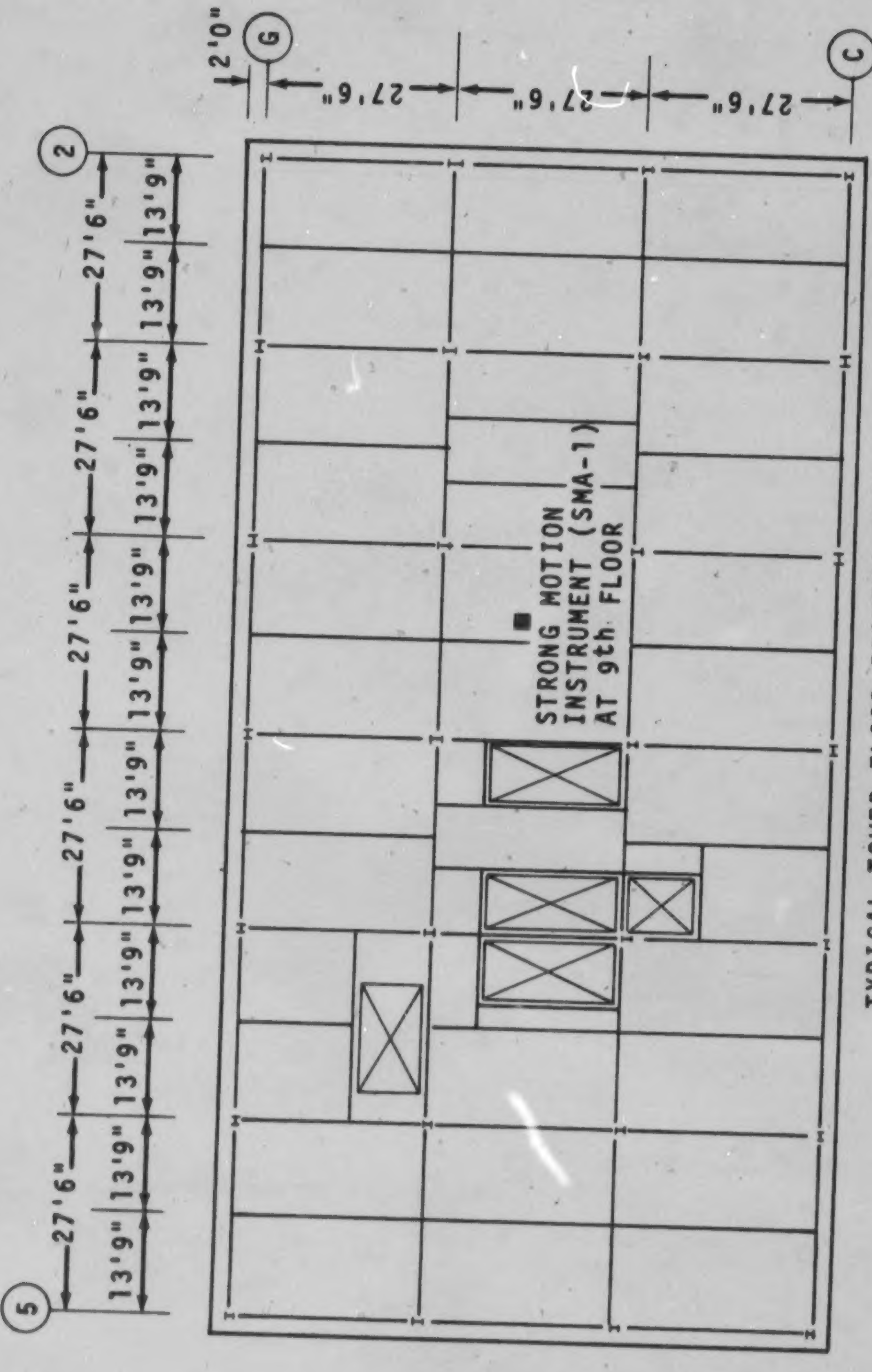
The buildings used in these example problems are each described in detail in [D.1]. Six general structural types have been studied. The types are: (1) Moment Resisting Steel Frame, (2) Braced Steel Frame, (3) Moment Resisting Concrete Frame, (4) Concrete Shear Wall, (5) Concrete Frame with Infill Walls and (6) Masonry Load Bearing. Since the damage in each of these buildings is to be evaluated for the San Fernando Earthquake -- February 9, 1971, each section presents a brief qualitative summary of building damage.

Steel Frame Building - Moment Resisting

This steel building is described in [D.1] in a technical paper by William E. Gates entitled Building Report No. 32. The paper presented the results of a detailed analytical model of the building and compared the calculated dynamic response with that recorded on strong motion instruments during the San Fernando earthquake. Earthquake and ambient natural periods for this building are available in [3.50] and [3.51].

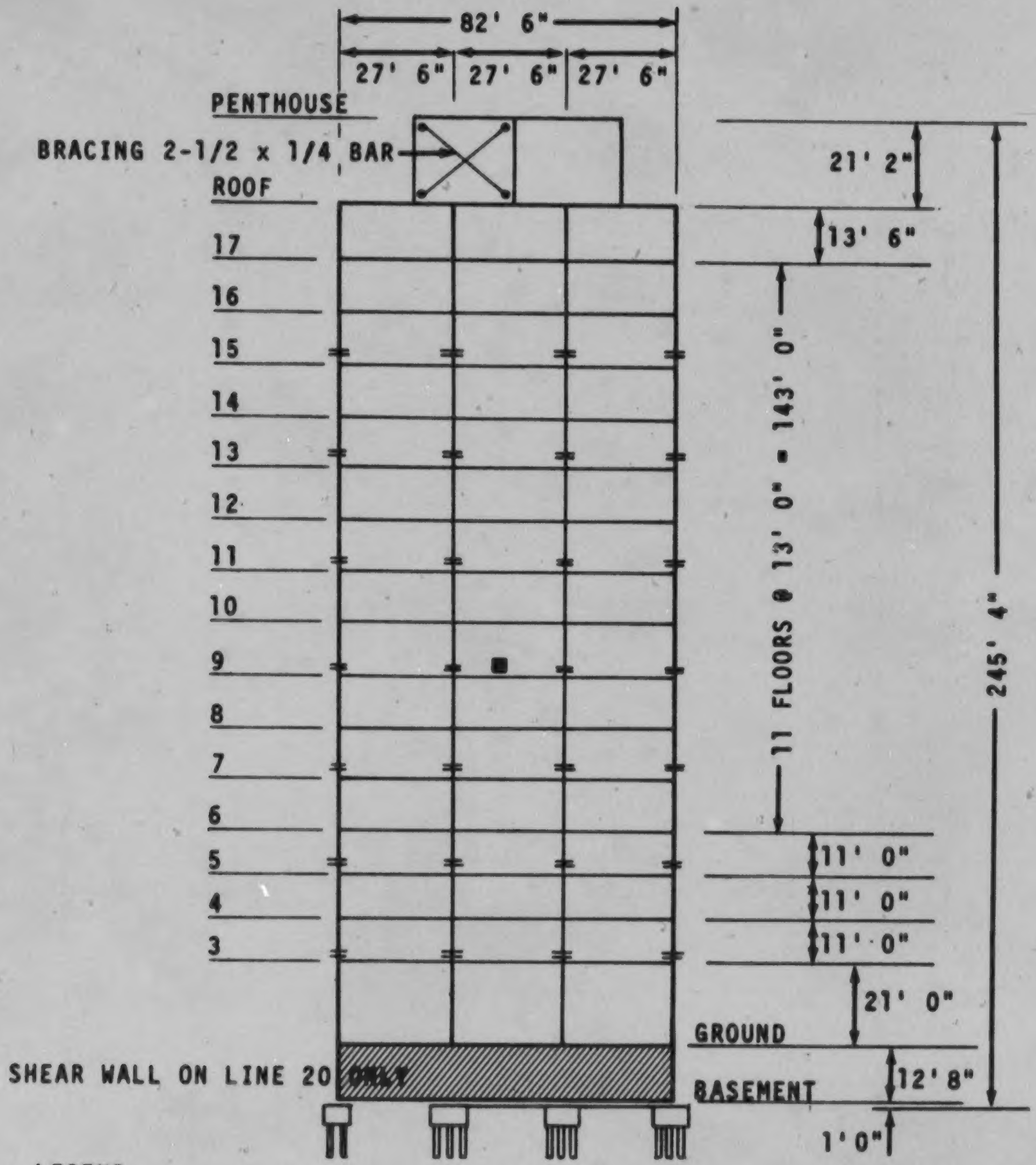
Building No. 32 is a 16 story office building. A typical floor plan is shown in figure D.1 with North-South and East-West elevations shown in figure D.2. The vertical load carrying system is a three-dimensional steel space frame. Lightweight concrete slabs are used in composite construction with the beams of the frame to support the floor loads and to form a rigid floor diaphragm under lateral forces. The four frames around the perimeter resist all lateral forces as moment resisting frames. The frames are constructed from deep welded plate girders and standard wide-flange columns. All connections are full moment connections obtained by welding the girder flanges and web to the column.

Estimated cost of the building when constructed in 1970 was four million dollars. The building is located in the San Fernando Valley and is approximately 17 miles from the February 9, 1971 San Fernando earthquake epicenter. Soil site conditions are mainly clayey sands and silty sands. The building rests on Raymond step-tapered piles averaging 54 feet in length. Peak ground acceleration in the longitudinal and transverse directions during the San Fernando earthquake were 13.2 and 15.3 percent gravity, respectively. Corresponding peak roof accelerations were 22.0 and 23.1 percent, respectively.


G
C
2
5
2'0"
27'6"
27'6"
27'6"
27'6"
27'6"
27'6"
27'6"
27'6"
27'6"
27'6"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
13'9"
STRONG MOTION INSTRUMENT (SMA-1) AT 9th FLOOR

TYPICAL TOWER FLOOR FRAMING PLAN

Figure D-1 Plan View - Building No. 32


82' 6"
27' 6"
27' 6"
27' 6"
PENTHOUSE
BRACING 2-1/2 x 1/4 BAR
ROOF
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
GROUND
BASEMENT
SHEAR WALL ON LINE 20 ONLY
21' 2"
13' 6"
11 FLOORS @ 13' 0" = 143' 0"
245' 4"
11' 0"
11' 0"
11' 0"
21' 0"
12' 8"
1' 0"

LEGEND:

- ↱ PINNED CONNECTION
- † COLUMN SPLICE
- ■ STRONG MOTION INSTRUMENT

Figure D-2a North-South Frames on Lines '5' and '20'- Building No. 32

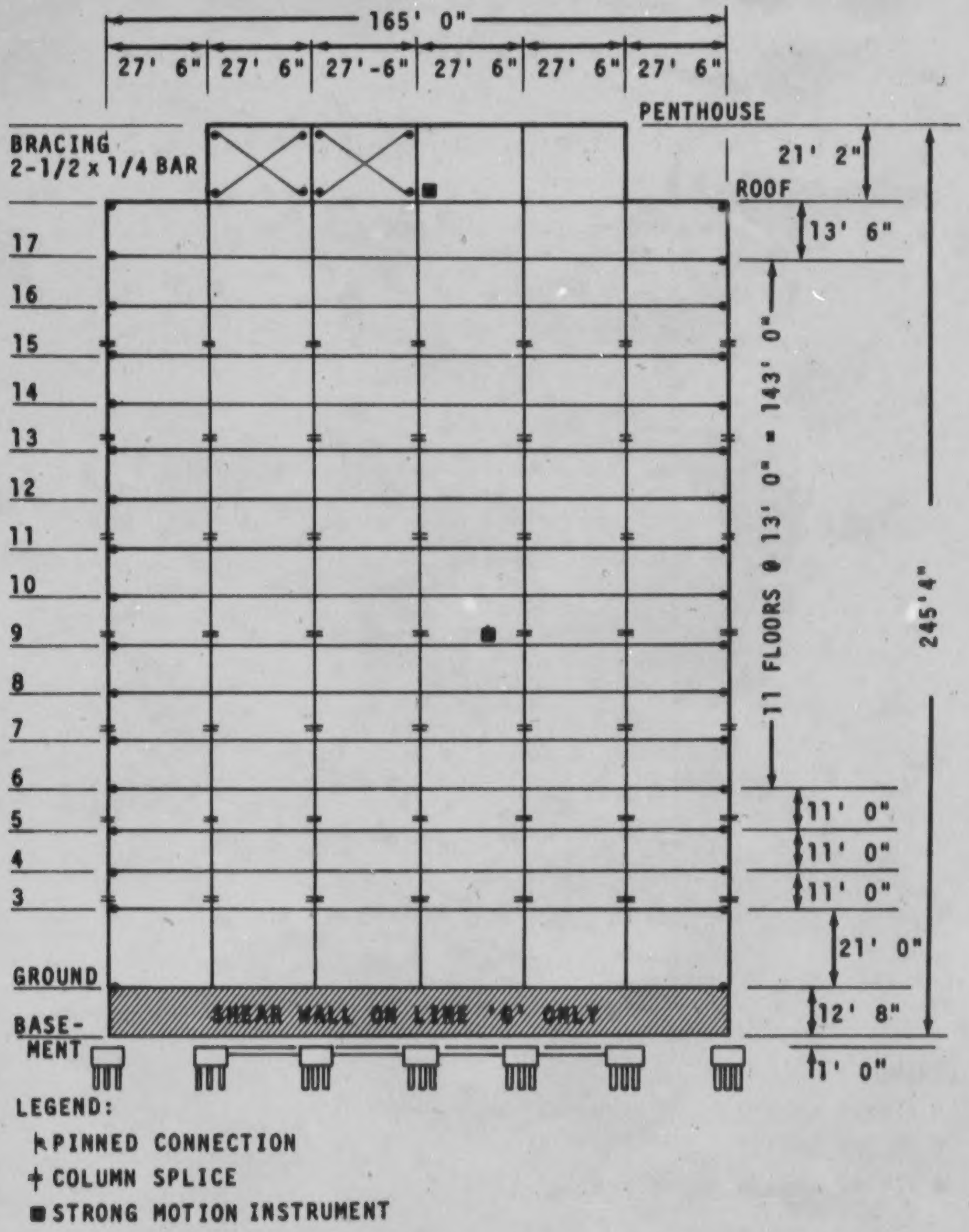

165' 0"
27' 6"
27' 6"
27'-6"
27' 6"
27' 6"
27' 6"
PENTHOUSE
BRACING
2-1/2 x 1/4 BAR
21' 2"
ROOF
13' 6"
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
GROUND
BASE-
MENT
11 FLOORS @ 13' 0" = 143' 0"
245'4"
11' 0"
11' 0"
11' 0"
21' 0"
12' 8"
1' 0"
SHEAR WALL ON LINE 'G' ONLY
LEGEND:
PINNED CONNECTION
COLUMN SPLICE
STRONG MOTION INSTRUMENT

Figure D.2b East-West Frames on Lines 'C' and 'G' -- Building No. 32

The following conclusions are quoted from the paper by William E. Gates:

" 1. Calculated first mode, dynamic force response exceeded current 1970 Uniform Building Code seismic force values by 70% in the North-South direction, and by 120% in the East-West direction.

2. The envelope of dynamic maximum force response exceeds current code design forces by an average value of 110% in the North-South direction, and by 170% in the East-West direction.

3. Maximum stress levels in 30% of the members in the North-South frames were calculated to have exceeded yield values at least once during the earthquake. In the East-West direction, 80% of the lateral force resisting members were calculated to have exceeded initial yield stress.

4. Columns reached initial yield stress before the girders.

5. The general performance of the structure was linear-elastic with only minor lengthening of building periods during the earthquake.

6. A significant portion of the maximum building response was in the second and third modes. In fact, the story forces produced by the second and third modes exceeded the first mode values in both of the horizontal directions of building motion.

7. Structural damping was found to vary from mode to mode with the higher damping values associated with the longer period or fundamental modes.

8. The office tower and adjacent parking structure are known to have impacted at the 5th floor level during major North-South building motion. This was evident by the marks left from building pounding at the seismic separation.

9. The influence of local soil conditions upon the ground motions recorded at the site was distinctly evident in the North-South response spectrum. Site amplification effects would have easily doubled the forces produced by this earthquake in a building constructed at the site with a fundamental period of 1.7 seconds.

10. Vertical roof accelerations equaled the horizontal acceleration, indicating that vertical amplification of ground motion can be significant.

11. No structural damage occurred during the earthquake. Nonstructural damage to drywall, seismic closures, and equipment supports amounted to an estimated $3,000 in repairs or roughly one cent per square foot of usable building space." [D.1]

Steel Frame Building -- Lateral Bracing

This building is described in [D.1] in a paper by Gary C. Hart entitled Building Report No. 37. The building is located approximately 24 miles from the San Fernando earthquake epicenter and is 19 stories above ground. There are four parking levels below ground level and the foundation rests upon steel piles averaging approximately 72 feet in depth. The building is located in the southern California building complex known as Century City. The building was built in 1967 at an estimated cost of 17 million dollars.

Figures D.3 and D.4 show plan and elevation views of the building. Lateral forces are resisted in the East-West direction by four moment resisting frames. However, in the North-South direction, five cross-braced steel frames resist all lateral forces.

Peak basement accelerations in the longitudinal and transverse directions during the San Fernando earthquake were recorded to be 17 and 14 percent of gravity, respectively. Corresponding roof peak accelerations were 7 and 14 percent, respectively.

A detailed damage survey was carried out on this building after the San Fernando earthquake, see [D.2] and table D.1.

Table D.1 SAN FERNANDO EARTHQUAKE LOSS BUILDING NO. 37 [D.2]

I. OWNER INCURRED REPAIR COSTS	
Repair three corner sofitts over podium around building	$ 761.00
Ground floor broken window replacement	113.00
Repair corridor vinyl wall covering damage	337.00
Ceiling Tile replacement, labor	969.00
Ceiling tile replacement, materials	2,000.00
Subtotal Repair Costs (a)	$4,180.00
II. OWNER INCURRED PAINTING COSTS	
Stairwells	$8,400.00
Suites 938, 1261, 1401, 540. 670, 1521, 1145	270.00
Suite 1800	250.00
Suite 1500	35.00
Suite 750	480.00
Suite 800	100.00
Suite 590	69.00
Subtotal Painting Cost (b)	$9,604.00
TOTAL OWNER INCURRED NON-STRUCTURAL COSTS (a + b)	$13,784.00
III. OCCUPANT INCURRED OFFICE CLEAN-UP COSTS	$ 5,604.00

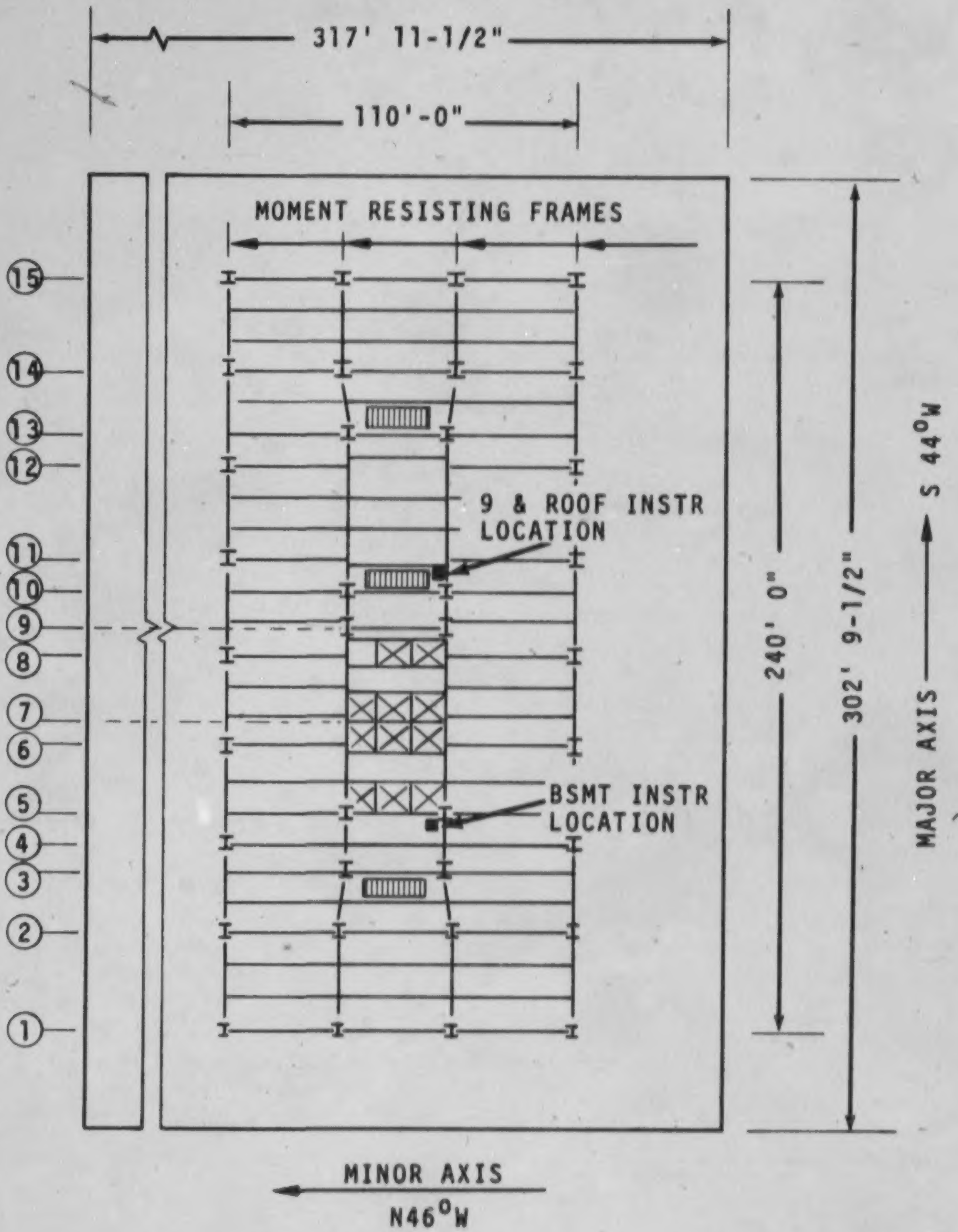

317' 11-1/2"
110'-0"
MOMENT RESISTING FRAMES
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
9 & ROOF INSTR LOCATION
BSMT INSTR LOCATION
240' 0"
302' 9-1/2"
S 44°W
MAJOR AXIS
MINOR AXIS
N46°W

Figure D.3 Typical Floor Plan - Building No. 37

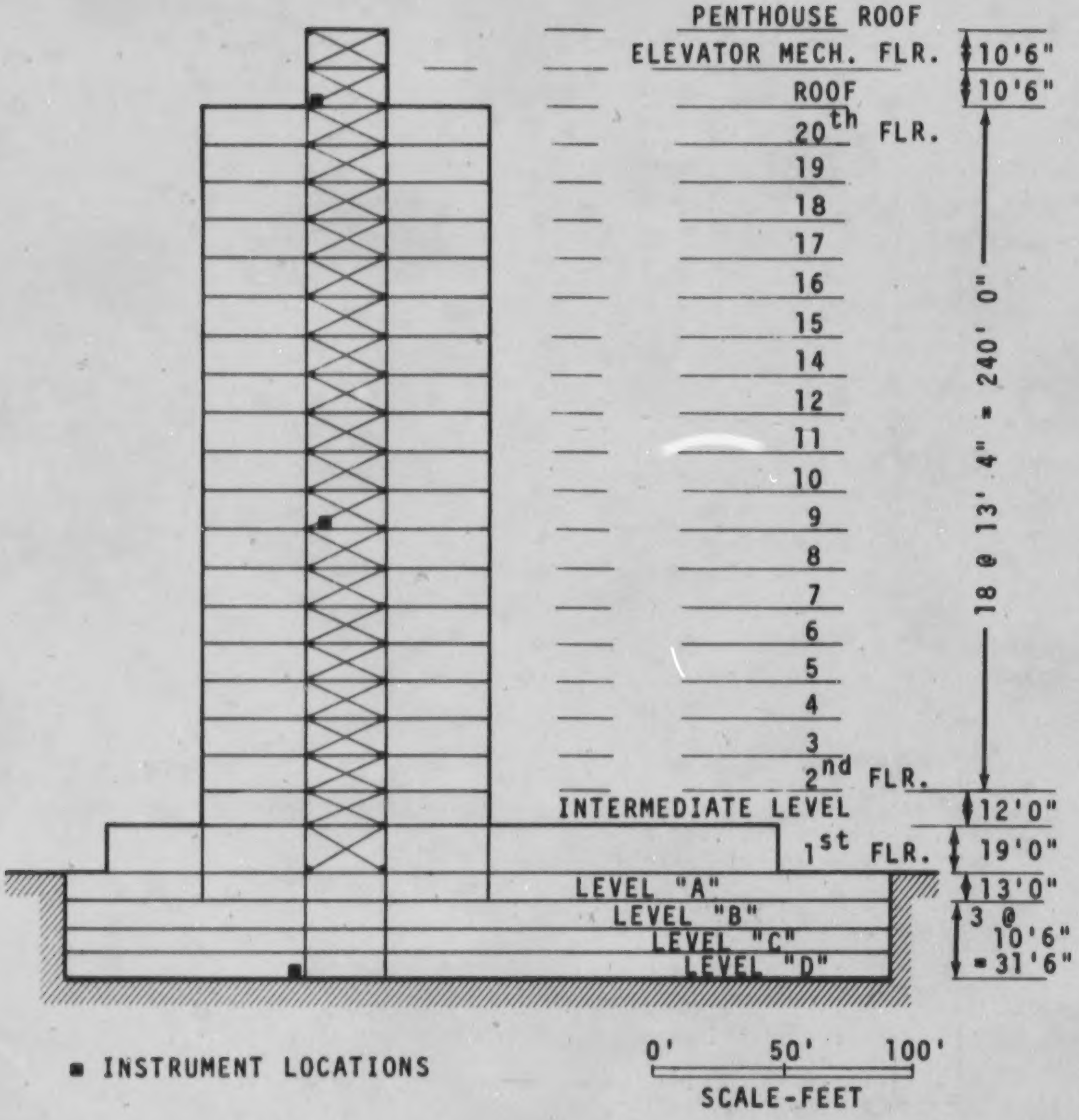

PENTHOUSE ROOF
ELEVATOR MECH. FLR.
ROOF
20th FLR.
19
18
17
16
15
14
12
11
10
9
8
7
6
5
4
3
2nd FLR.
INTERMEDIATE LEVEL
1st FLR.
LEVEL "A"
LEVEL "B"
LEVEL "C"
LEVEL "D"
10'6"
10'6"
18 @ 13' 4" = 240' 0"
12'0"
19'0"
13'0"
3 @ 10'6" = 31'6"
■ INSTRUMENT LOCATIONS
0'
50'
100'
SCALE-FEET

Figure D.4 Elevation of N46°W Frame -- Building No. 37

Concrete Frame Building -- Moment Resisting

Reference [D.1] contains a paper entitled Building No. 28 by John A. Blume and Associates which describes the earthquake response of a twelve story reinforced concrete building to the San Fernando earthquake. The building is located approximately 17 miles from the earthquake epicenter and incurred repair costs of $44,000. Of this loss, approximately $12,000 was structural damage. It is to be noted that while not stated in the cited paper the fourth through seventh floors were not occupied at the time of the earthquake and hence no internal partitions existed. Therefore, it is reasonable to expect that the nonstructural damage would exceed the amount reported if the building had been occupied. The building was constructed in 1970 at an approximate cost of $4 million.

Figures D.5 and D.6 show a typical plan and elevation view of the building. Typical floor construction consists of 4-1/2 inch slab on a 17-inch deep pan-joist system, which spans from girder to girder. Lightweight concrete is used for all floors and girders. Columns are rectangular and tied and regular weight stone aggregate is used.

Besides the referenced study, an estimate of ambient, aftershock and earthquake dynamic response parameters was reported in a paper at the International Conference on Microzonation, see [D.3].

The following conclusions are quoted from Building Report No. 28 [D.1]:

"(1) The building resisted the earthquake largely by inelastic means with local yielding of reinforcement and with cracking and localized spalling of column and girder concrete.

(2) The structural response of the building was non-linear and cannot be well described or modeled by linear elastic dynamic analysis techniques.

(3) Calculated earthquake forces were substantially greater than prescribed code minimums. Calculated story shears were greater than 2.5 times code values, and calculated overturning moments were about 2.0 times code values with $J = 1$.

(4) Architectural damage was related to interstory displacements and consisted largely of cracking, racking, and working of partitions. Some mechanical equipment and building contents were damaged by shaking alone.

(5) Structural damage did occur, but it was limited to cracking and minor spalling of concrete. Yielding of reinforcement in localized areas also occurred." [D.1]

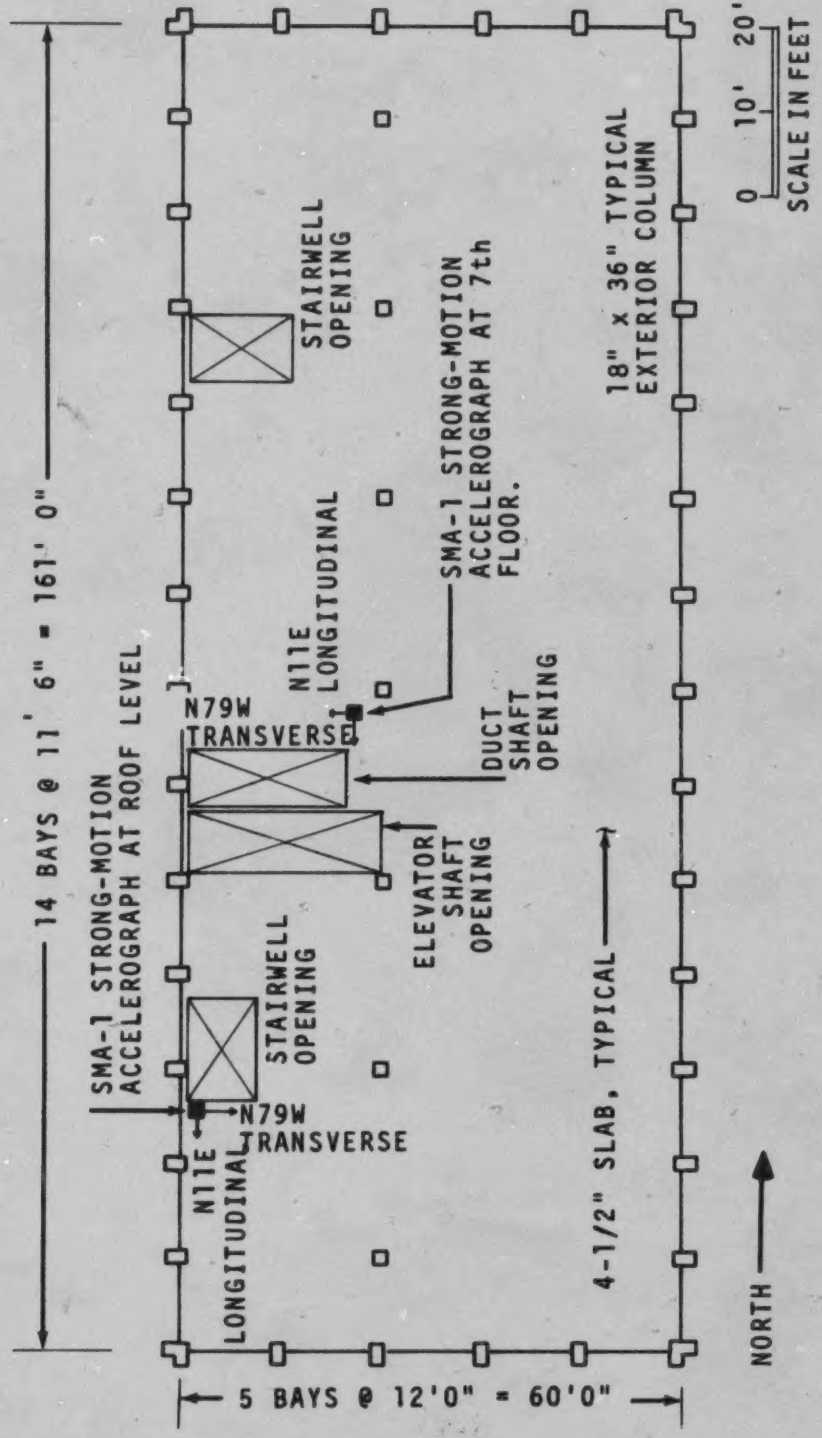

14 BAYS @ 11' 6" = 161' 0"
SMA-1 STRONG-MOTION ACCELEROGRAPH AT ROOF LEVEL
N79W TRANSVERSE
N11E LONGITUDINAL
STAIRWELL OPENING
ELEVATOR SHAFT OPENING
DUCT SHAFT OPENING
N79W TRANSVERSE
N11E LONGITUDINAL
SMA-1 STRONG-MOTION ACCELEROGRAPH AT 7th FLOOR.
STAIRWELL OPENING
4-1/2" SLAB, TYPICAL
18" x 36" TYPICAL EXTERIOR COLUMN
0
10'
20'
SCALE IN FEET
NORTH
5 BAYS @ 12'0" = 60'0"

Figure D.5 Typical Floor Plan - Building No. 28

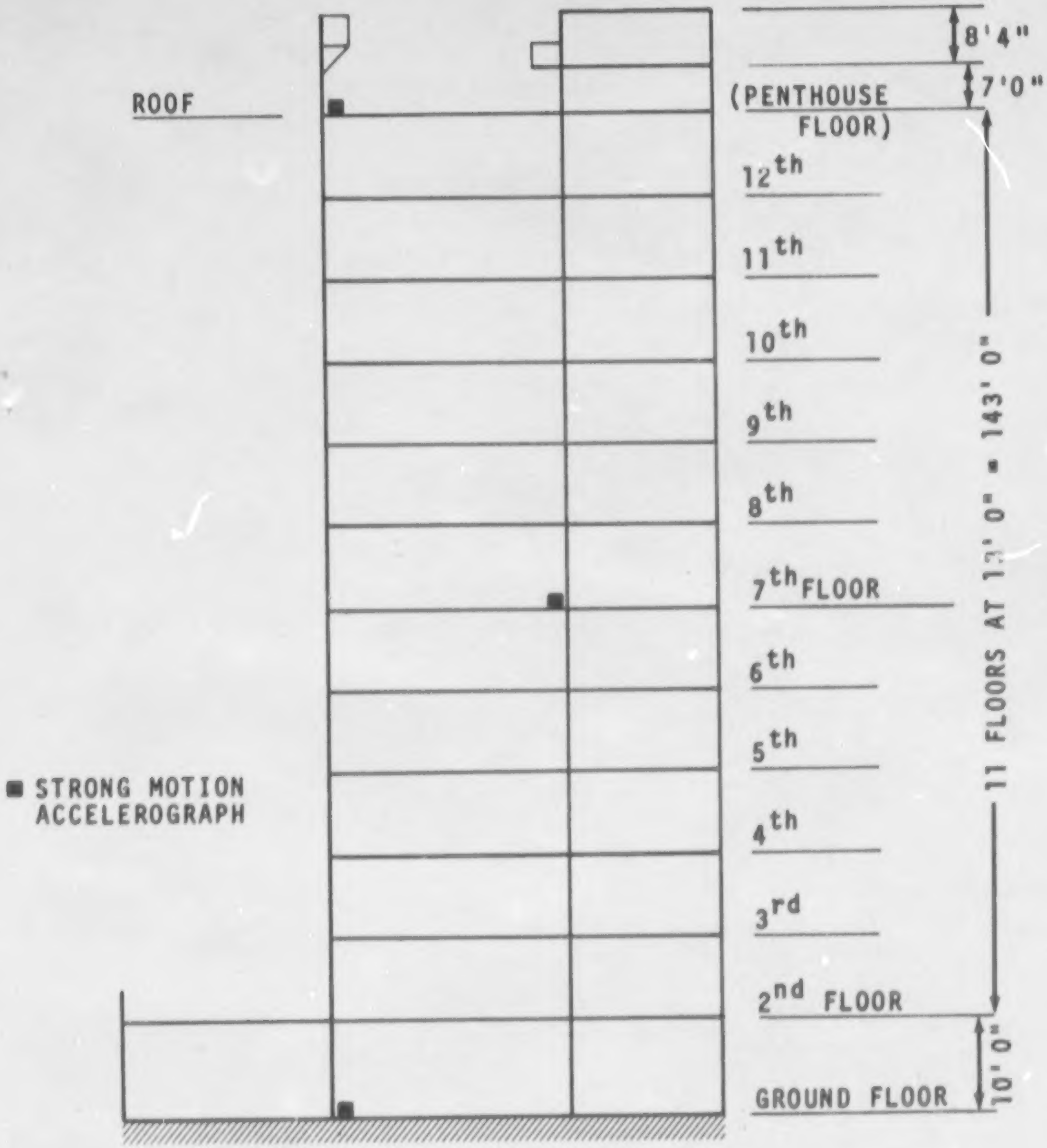

ROOF
8'4"
7'0"
(PENTHOUSE FLOOR)
12th
11th
10th
9th
8th
7th FLOOR
6th
5th
4th
3rd
2nd FLOOR
GROUND FLOOR
11 FLOORS AT 13' 0" = 143' 0"
10' 0"
■ STRONG MOTION ACCELEROGRAPH

Figure D.6 Typical Transverse Section - Building No. 28

Concrete Frame Building -- Shear Wall

Building Report No. 35 in [D.1] presents the seismic investigation of a high-rise building following the 1971 San Fernando earthquake. Among the instrumented buildings investigated following the San Fernando earthquake and reported on in [D.1] this 14 story building was the only building with a lateral force resisting system composed of shear walls extending throughout the full structural height. This building was constructed in 1966 at an estimated cost of 3 million dollars. The price does not include tenant improvements. Nonstructural damage was estimated at $2,000. Mechanical repair costs on the air conditioning chiller amounted to $30,000. There was no observed structural damage.

Figures D.7 and D.8 show plan and elevation views of the building. The vertical load carrying system consists of reinforced concrete flat slabs supported by columns and bearing walls. These bearing walls also serve as shear walls under lateral loads. All floor slabs are constructed from lightweight concrete. Twelve inch thick shear walls comprise the lateral force resisting system. Stone aggregate concrete weighing 150 pounds per cubic foot was used for the shear walls.

On the basis of an elastic dynamic structural analysis described in [D.1] the following conclusions were made:

"(1) Acceleration response in the North-South direction was 50% greater than East-West.

(2) First mode damping in the North-South direction was estimated to be 5% while the East-West direction was set at 7%.

(3) In the North-South direction maximum building displacements were 300% greater than those produced by current code practice and design values. For East-West displacement, the envelope of dynamic earthquake response was 80% greater than current code design.

(4) The maximum story drift of 1/4 inch occurs between the 8th floor and the roof for the North-South direction.

(5) Comparing the envelope of dynamic maximum shear response to code values, at ground level in the North-South direction, enveloped shears are 70% greater than code shears, while in the East-West direction dynamic values are 30% greater than static code shears.

(6) The general performance of the structure was linear-elastic with only minor lengthening of building periods during the earthquake."[D.1]

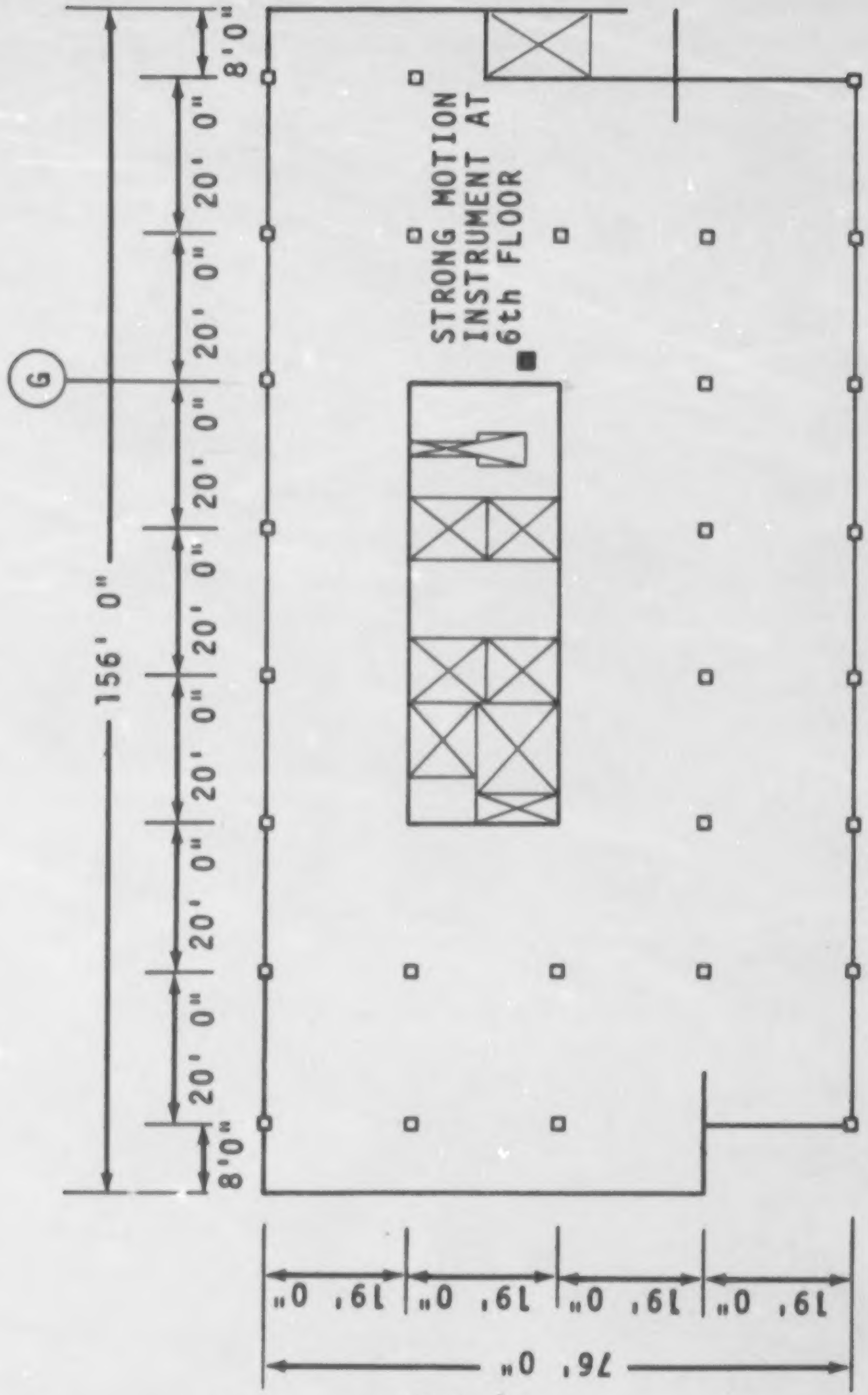

156' 0"
8'0"
20' 0"
20' 0"
20' 0"
20' 0"
20' 0"
20' 0"
20' 0"
8'0"
G
STRONG MOTION INSTRUMENT AT 6th FLOOR
19' 0"
19' 0"
19' 0"
19' 0"
76' 0"

Figure D.7 Typical Floor Plan - Building No. 35

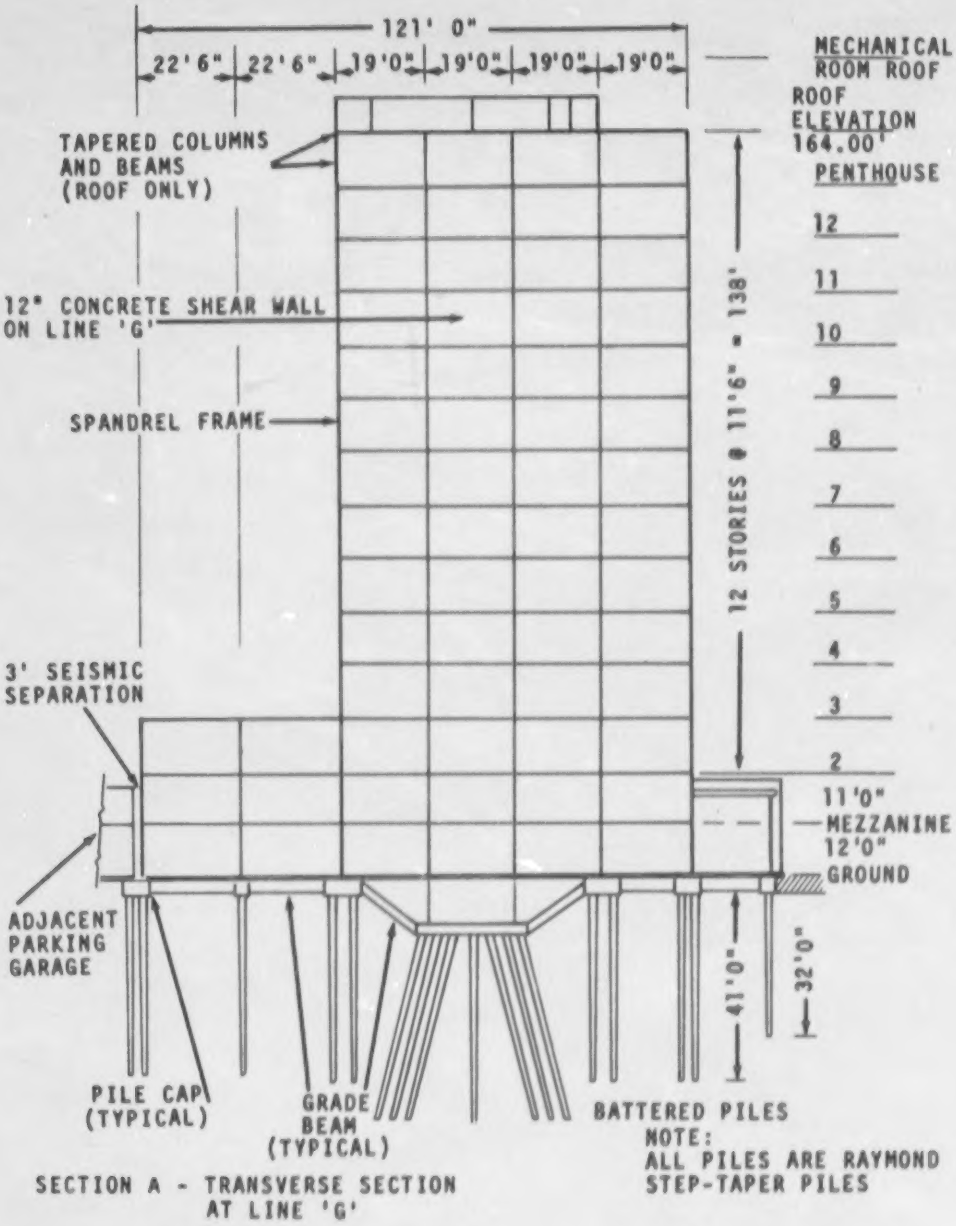

121' 0"
22'6"
22'6"
19'0"
19'0"
19'0"
19'0"
MECHANICAL ROOM ROOF
ROOF ELEVATION 164.00'
PENTHOUSE
12
11
10
9
8
7
6
5
4
3
2
11'0"
MEZZANINE
12'0"
GROUND
12 STORIES @ 11'6" = 138'
TAPERED COLUMNS AND BEAMS (ROOF ONLY)
12" CONCRETE SHEAR WALL ON LINE 'G'
SPANDREL FRAME
3' SEISMIC SEPARATION
ADJACENT PARKING GARAGE
41'0"
32'0"
PILE CAP (TYPICAL)
GRADE BEAM (TYPICAL)
BATTERED PILES
NOTE: ALL PILES ARE RAYMOND STEP-TAPER PILES
SECTION A - TRANSVERSE SECTION AT LINE 'G'

Figure D.8 Transverse Building Section - Building No. 35

Concrete Frame Building -- Infill Walls

Building Report No. 29 in [D.1] was authored by John A. Blume & Associates and describes the earthquake response of a concrete building. The referenced paper conducted a detailed dynamical model of this seven story reinforced concrete structure. Recorded San Fernando basement accelerograms were input to an analytical model and the calculated building response compared with recorded response.

Figures D.9 and D.10 show plan and elevation views of the building. All lateral force resisting columns are regular weight reinforced concrete. Spandrel beams surround the perimeter of the structure and reinforced concrete flat slabs are used -- typically 8 inches thick. Interior partitions are gypsum wallboard on metal studs. One inch thick cement plaster is used for exterior facing at each end of the building. Double 16-gauge metal studs support the cement plaster. All lateral forces are resisted by interior column-slab frames and by exterior column-spandrel beams.

The building construction cost was approximately 1.3 million dollars in 1966 and after the San Fernando earthquake the repair cost to the building was approximately $145,000 (approximately $2,000 was structural). The following conclusions were made in [D.1]:

"(1) During the earthquake, the structure responded at amplitudes that exceeded the elastic limits of a substantial number of girders.

(2) Calculated earthquake forces exceeded prescribed code minimums by a factor of 4 or 5.

(3) Interstory displacements exceeded 1 inch. This accounts for the large amount of nonstructural damage.

(4) On the basis of calculated building response, maximum lateral displacements were from 15 to 20 times prescribed code minimums, but observed structural damage was relatively minor.

(5) Estimates of ductility indicate average ratios of 8 for beams and slabs in the transverse direction and 6 for beams and slabs in the longitudinal direction.

(6) Damping was approximated to be 5% to 10% of critical viscous damping.

(7) Although there was some vertical amplification of vertical ground motion, peak resulting stresses were only approximately 20% of dead and live load stresses."[D.1]

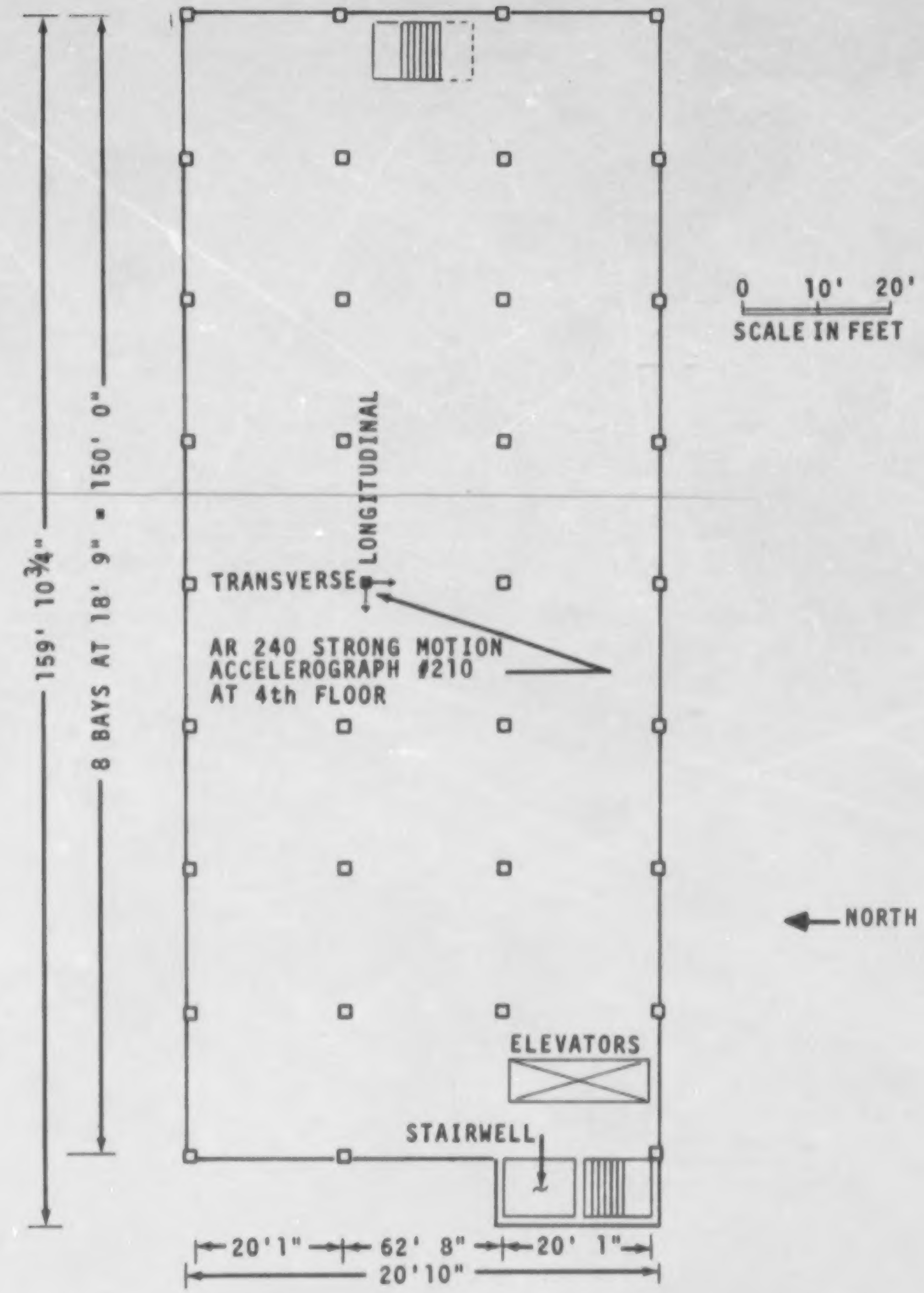

159' 10¾"
8 BAYS AT 18' 9" = 150' 0"
LONGITUDINAL
TRANSVERSE
AR 240 STRONG MOTION
ACCELEROGRAPH #210
AT 4th FLOOR
0 10' 20'
SCALE IN FEET
NORTH
ELEVATORS
STAIRWELL
20'1"
62' 8"
20' 1"
20'10"

Figure D.9 Typical Floor Framing Plan -- Building No. 29

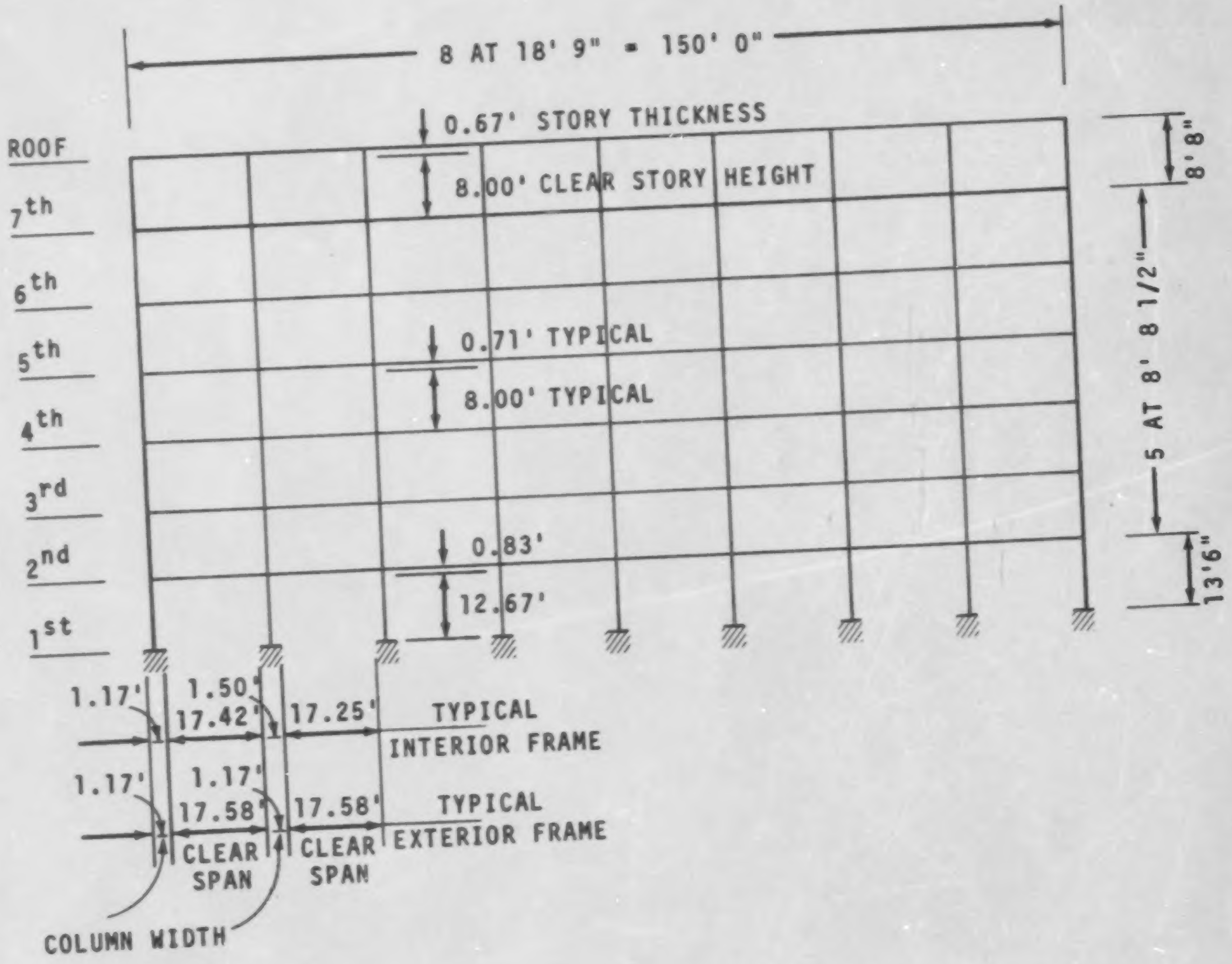
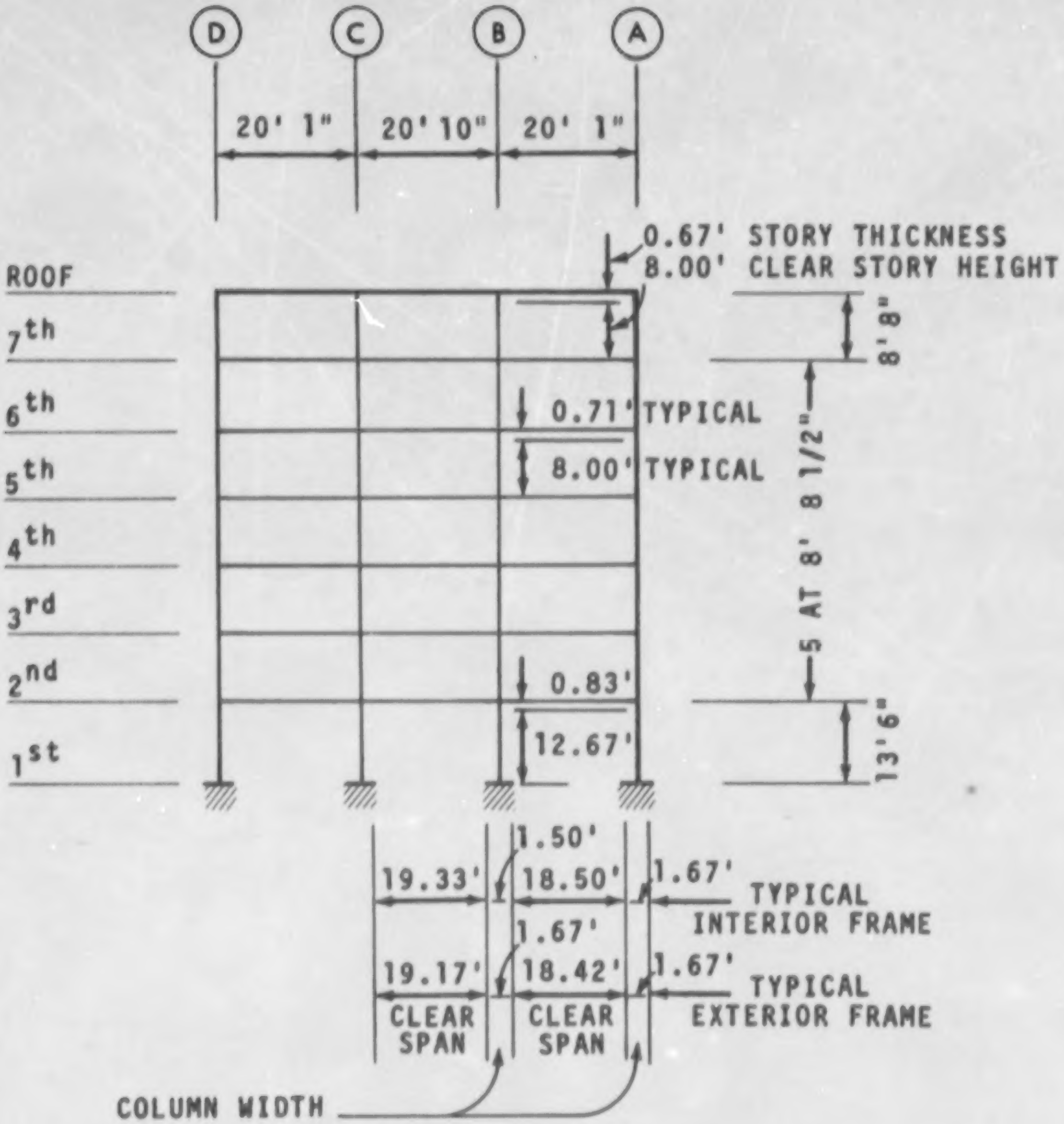

8 AT 18' 9" = 150' 0"
0.67' STORY THICKNESS
8.00' CLEAR STORY HEIGHT
0.71' TYPICAL
8.00' TYPICAL
0.83'
12.67'
ROOF
7th
6th
5th
4th
3rd
2nd
1st
8'8"
5 AT 8' 8 1/2"
13'6"
1.17'
1.50'
17.42'
17.25'
TYPICAL
INTERIOR FRAME
1.17'
1.17'
17.58'
17.58'
CLEAR
SPAN
CLEAR
SPAN
TYPICAL
EXTERIOR FRAME
COLUMN WIDTH

Figure D.10a Typical Longitudinal Frame -- Building No. 29



D
C
B
A
20' 1"
20' 10"
20' 1"
0.67' STORY THICKNESS
8.00' CLEAR STORY HEIGHT
ROOF
7th
6th
5th
4th
3rd
2nd
1st
8'8"
0.71' TYPICAL
8.00' TYPICAL
5 AT 8' 8 1/2"
0.83'
12.67'
13'6"
1.50'
19.33'
18.50'
1.67'
TYPICAL INTERIOR FRAME
1.67'
19.17'
18.42'
1.67'
TYPICAL EXTERIOR FRAME
CLEAR SPAN
CLEAR SPAN
COLUMN WIDTH

Figure D.10b Typical Transverse Frame -- Building No. 29

Masonry Building -- Load Bearing

Morningside School, Building #1, in the City of San Fernando, California was constructed in 1915. Of the pre-1933 Field Act Schools, Morningside was closest to the center of the 1971 San Fernando earthquake (about 8 miles). A limited description of the building is given [3.51] and [D.4].

> "The building is a two-story "T" shaped concrete bearing wall structure. The original construction had a wood framed gabled roof with heavy slate roofing. Floor framing consisted of wood joists and sheathing. The exterior walls were concrete having an ultimate compressive strength of approximately 900 psi. The partitions were wood studs with plaster on wood strip lath. The building rests on spread foundations. In 1964, the building was reinforced by removing the heavy slate roofing, installing new plywood sheathing in the plane of the second-story ceiling, anchoring the floors and roof to the walls, installing a plywood shear-resisting element in the attic to stabilize the gabled roof framing in the longitudinal direction, and the installation of additional roof supports. New concrete shear-resisting wall panels were added since Title 21 considers concrete with a compressive strength below 1500 psi the same as unreinforced brickwork."
>
> "The reconstructed building was designed for a 15%g acceleration force, and it came through the earthquake with no structural damage except some overstraining where the gable walls were anchored to the roof framing. Some plaster fell off the 1915 interior partitions. This was a good test of the program for rebuilding old schools to meet the Field Act requirements."

B. TORNADO AND HURRICANE DAMAGE EVALUATION BUILDINGS

Steel Frame Building

There is a lack of good quality damage data for steel frame buildings during strong wind storms. A Texas Tech Report [3.39] describes in some detail the damage to the Great Plains Life Building in Lubbock, Texas during the May 11, 1970 tornado. This report presents a general structural description of the building as well as considerable pertinent and interesting observations.

The building is a 20 story steel frame with a 125 x 56 ft tower plan and a 125 x 75 ft three-story base plan. Of particular importance in the structural dynamic behavior of this building, is the existence of a very stiff north end relative to south, thus causing significant structural torsional eccentricity.

The following quotations from the Texas Tech report indicate the character of the building's damage:

> "Damage to the building was classified as severe. All tenants have vacated the building and will not return until extensive repairs are completed. The steel frame sustained permanent deformation which exceeds the tolerances allowed for a structure to be out-of-plum. The top of the frame is deformed 12 in. to the east with respect to the base. The damage to the exterior face brick is such that a completely new exterior cladding will likely be required. On the interior many partition walls have collapsed and the plaster on the walls and ceilings is extensively cracked.
>
> A quick glance at the building immediately after the storm revealed that it had been through quite an ordeal. Twenty-seven percent of all window panes were broken. The most severe glass damage was at the southwest corner of the building where there were large rooms with windows on both the south and west sides. This seems reasonable since the wind was from the southwest. Window glass was broken primarily by missiles. The interior hallway partitions did not collapse, so it was not possible for debris to blow completely through the building.
>
> Beginning at the fourth floor level, the damage at the south end of the building was very severe. Interior partitions, particularly those running in an east-west direction, were cracked by diagonal tension. Between floors five and nine all east-west partitions have moved approximately 1 in. to the east with respect to the floor. In the hallways a bulge occurred at each east-west partition. These partitions were not anchored to the floor and extended up to the suspended plaster ceiling. Where partitions collapsed, it appears that they were first cracked by the racking of the building. Then, having been weakened, they collapsed due to either positive or negative pressure from the storm.
>
> The encasements around the columns, formed by gypsum block and covered with 1 in. of plaster, were severely cracked. These cracks then propagated into the adjoining walls. In some instances, these vertical cracks in the column encasement remained open by as much as 1 in. Since there was a clear space of at least 1 in. between the steel column and the gypsum blocks, the relative column deflection must have been 2 in. or more on a given floor.
>
> With a few exceptions, the aluminum window frames were not damaged by the wind. Glass breakage was inconsistently high for the wind velocities estimated at the lower elevations. This high incidence of glass breakage was attributed to racking of the building frame and to missiles. At the upper elevations the percentage of glass broken was consistent with estimated wind velocities.

It was first thought that the deformation of the frame was elastic and that the frame was prevented from returning to its original straight position by frictional resistance developed in the partitions and walls. The interior partitions, suspended ceiling and the south exterior wall at the fifth and sixth floor were removed. However, no elastic rebound occurred. The frame was indeed permanently deformed.

With the steel skeleton stripped at the fifth and sixth floors, it was possible to take a closer look at the structural frame. The column splices which are located immediately above the fifth floor level were found to be intact. There was no evidence of failure of any rivets. The relative movement of one end of the column with respect to the other end was considerable at this level. The maximum slope observed was 0.375 in. in 24 in. This corresponds to a relative movement of 2.25 in. in the 12 ft story height.

The major bending deformation due to sidesway takes place in the columns rather than the beams (strong beam-weak columns). There is, however, some evidence of yielding in the beams. A check of the column flange with a carpenter's level revealed that the column has a slope of 0.125 in. in 12 in. The column flange is plumb opposite the beam connection, indicating that there is no measurable rotation of the joints.

The location of the service shafts and the solid masonry wall at the north end of the building resulted in a structure which was more flexible at the south end of the building. If the service shaft had been in the center of the building or at both ends, the structure would have sustained much less structural and superficial damage. The lack of stiffness at the south end permitted excessive deformations causing damage to the steel frame and extensive cracking of walls and partitions.

Because the north end of the building is much stiffer than the south, the structure tended to rotate about a vertical axis near the north end of the building. Thus the building deflected in a lateral-torsional mode. Evidence of this mode of deflection is found in the large diagonal cracks in the masonry at the north end of the building. Cracks produced by torsional shear were also found in the stairwell on the lower floors. The extent of the damage due to this mode of response appears to be in the exterior walls and possibly in the elevator shafts."[3.39]

It is evident from the preceding comments that the particular structural framing character of this building lead to significant torsional response. The damage evaluation program used herein does not, as mentioned in section 3.4, enable the modeling of a building's torsional motion. However, the damage based on a two-dimensional building model will be evaluated because of the wind engineering significance of the Great Plains Life Building and also to see if the state-of-the-art two-dimensional wind damage model would have predicted serious damage for this building.

The exact cost of the building and its dollar damage are not detailed in the Texas Tech report. However, it is evident that the damage was very severe and a general reference figure of $1.8 million is cited in the report. Based upon average building costs this dollar loss can be approximately estimated to represent fifty percent of the building's cost.

Concrete Frame Building

In Lubbock, Texas the First National Bank-Pioneer Gas Company Building experienced severe damage during the May 11, 1970 tornado. The cited Texas Tech report [3.39 also describes this 15-story reinforced concrete frame and the damage it experienced. The building was constructed in 1968 and was located near the edge of the extensive destruction zone. It is approximately two blocks from the Great Plains Life Building.

The Texas Tech Report offers the following interesting comparison between the response of the two noted Lubbock buildings:

> "The structural response of the Great Plains Life Building and the First National-Pioneer Building makes an interesting comparison. In the case of the First National-Pioneer Building the structural frame behaved adequately with no damage or excessive deflections. The damage resulted from failure of the exterior cladding. On the other hand, the exterior cladding of the Great Plains Life Building remained essentially intact and the damage was primarily due to racking of the structural frame. Yet the amount of damage to the two buildings in dollars is essentially the same.
>
> The structural integrity of the First National-Pioneer Building was never questioned in the press or by the general public. The Great Plains Life Building, on the other hand, suffered from bad publicity and rumors both prior to and after the tornado. As a result many people in Lubbock today would not enter that building. The First National-Pioneer Building has not experienced the bad psychological response of the general public." [D.5]

The report also offers the following comments relative to the observed damage to the building.

> "Damage to the building is classified as severe; however, it was not necessary to completely vacate the building. Many offices were not disturbed at all; some had only window damage and scattering of contents by the wind, while other offices were virtually destroyed. The private club on the top floor was completely demolished.
>
> Unlike the Great Plains Life Building, the First National-Pioneer Building received no damage to the structural frame. The rigidity of the reinforced concrete frame, due in part to the shape of the building, prevented excessive deformations of the structure. Hence, the damage due to racking of the building was minimal. Yet the cost to repair the First National-Pioneer Building is equal to, if not greater than, the cost to repair the Great Plains Life Building. Cost of repair to First National-Pioneer was reported to be $1.8 million.
>
> Each glass panel on the north and south exterior walls was 49 x 72 in. and had a nominal 13/64 in. thickness. The north leeward face of the building surprisingly suffered 60 percent more broken panes than the south windward face. This unexpected distribution has been attributed to some combination of two factors:
>
> (1) After windward panes broke, interior partition panels, office material, etc., were broken and the debris contributed to breakage on the far wall.
>
> (2) With windward panes out, stagnation pressure on the inside combined with occasional outward pressure on the leeward side generated differentials across leeward plate glass.
>
> However, the correlation between broken panels on the windward and leeward sides by floors was not good."[3.39]

Long Span Roof Structure

The Texas Tech Report [3.39] described in limited detail the damage done to the Tech Village Apartments by the Lubbock storm of May 11, 1970. The Tech Apartments is a complex of seven identically constructed buildings, see figure D.11. Each building in the complex is two story and rectangular in plan with loadbearing concrete block walls and metal deck roofing. The size of the buildings ranges from 14,000 to 21,000 square feet.

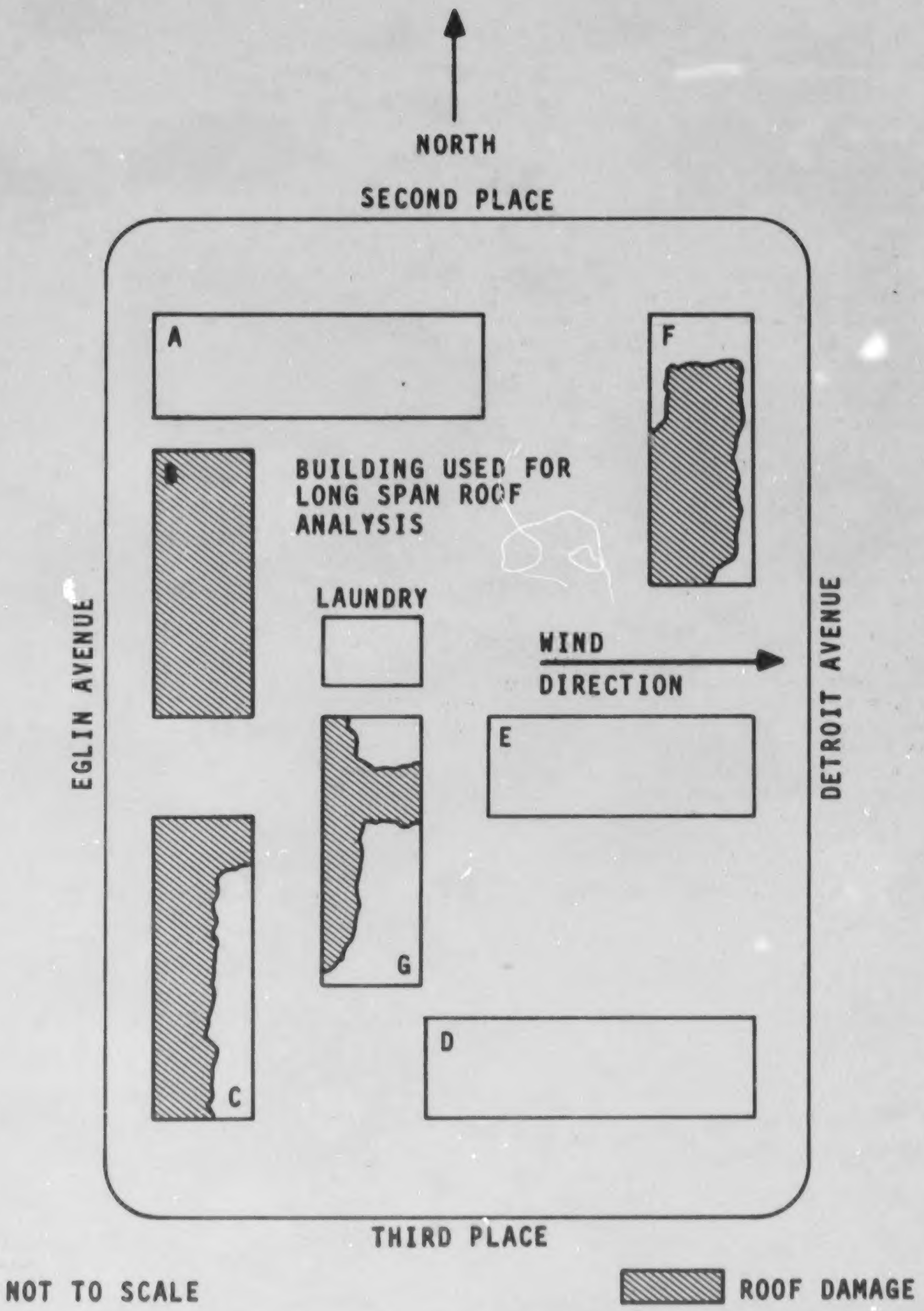

NORTH
SECOND PLACE
A
F
B
BUILDING USED FOR LONG SPAN ROOF ANALYSIS
LAUNDRY
WIND DIRECTION
EGLIN AVENUE
DETROIT AVENUE
E
G
C
D
THIRD PLACE
NOT TO SCALE
▨ ROOF DAMAGE

Figure D.11 Tech Village Apartment Complex

> "The exterior walls are constructed of concrete block. At the short end of the building the 12-in thick walls are made of 4-in brick backed by 8-in concrete block. A double concrete block wall runs in the longitudinal direction and divides each building in half. All interior partitions are concrete block and are load-bearing. The exterior walls and those partitions which separate individual apartments have bond beams at roof level. The bond beams are reinforced with two no. 8 bars. The second fibor slab is 4-in thick concrete resting on load-bearing masonry walls. The roof is made of light weight metal deck with fiber board insulation and built-up roof. The metal deck is spot welded to a small steel angle embedded inthe concrete of the bond beams. A 5 ft. wide exterior corridor gives access to the second floor apartments. The roof extends out to form a canopy for the corridor. The roof overhand and the second floor walkway are supported by 3 in. diameter pipe columns spaced 12-ft on centers. The overhand at roof level is supported by 6-in channels welded to the pipe columns and attached to small angles anchored to the bond beam at the exterior walls. The overhand at roof level is an integral part of the roof system."[3.39]

Damage to the complex is rated as severe. Again, quoting from the cited report:

> "The four buildings in this complex which sustained structural damage were the ones with their longitudininal axes oriented in the north-south direction. The major damage was the stripping off of the roof. Apparently the force of the wind striking the roof canopy on the west side of the buildings dislodged the metal deck from the top of the walls and peeled back the roof. The steel angles anchored in the bond beams pulled out, but they served to tie the metal deck together in large pieces; thus allowing the force of the wind to strip metal deck from the building. Some of the exterior walls collapsed, but most interior partitions at the second floor level remained intact. First floor apartments suffered very little structural damage."[3.39]

D.6 DAMAGE EVALUATIONS USING THE DETAILED EVALUATION METHOD

A. General Comments

This section presents damage evaluation estimates for earthquake, tornado and hurricane natural disasters. The buildings noted in section D.5 have been used in this evaluation. As noted in section 3.4 there exist many input parameters which require professional engineering judgment. Examples of these include: (1) building quality factor, (2) ductility to failure of structural and nonstructural members, (3) drift to yield, etc., This necessity to input professional judgment means that it is extremely likely that two independent engineers will when using the detailed computer program obtain different damage estimates. To assess the sensitivity which the different decisions have upon the final evaluation is beyond the scope of this study, however, the following example problems certainly provide some engineering insight into this area.

B. Earthquake Damage Evaluations

The results of damage evaluations conducted on each of the buildings noted in section D.5a are summarized. The earthquake damage evaluations are based upon magnitude and epicentral distances for the actual San Fernando earthquake. From the nature of the developed computer program, there exists a multitude of possible parameter permutations. In this section, the values of the parameters used to perform the evaluations are based upon data presented in section 3.4 and are realistic for the building under consideration.

For each building which is modeled using the empirical building model the estimated building period was obtained from [3.50] and reflects the observed San Fernando earthquake building period. When actual seismic response data does not exist the following two alternatives can be used: (1) use ambient building periods scaled up in magnitude by a value believed to be appropriate for the earthquake size and epicentral distance under consideration (e.g., usually 1.33 to 1.5) or (2) use existing formulas of the type described in section 3.4.

Table D.2 summarizes for each of the noted buildings the selected values of several of the important input parameters. The damage experienced by each of the buildings is estimated in two damage evaluation procedures. Option 1 in table D.3 is a summation of the floor-by-floor damage. All damage estimates are based upon the methodology described in section 3.4. Option 2 presents damage estimates which are based upon one engineer's professional experience. As the computer program outputs MMI values for each building floor it is only necessary for the engineer to average the MMI from all building floors to obtain an average building MMI.

Table D.2 SAN FERNANDO EARTHQUAKE EXAMPLES

Building	Fundamental Period (Sec)	Interstory Drift to Yield (in/in)	Quality Factor	Frame Ductility to Failure	Wall Ductility to Failure	Model Characterization
Building No. 32 (Steel-moment frame)	E-W = 3.28 N-S = 3.34	.013	3.0	18.0	7.0	Empirical
Building No. 37 (Steel-braced frame)	N-S = 3.43 E-W = 3.41	.013	3.0	18.0	7.0	Empirical
Building No. 28 (Concrete-moment frame)	N-S = 2.38 E-W = 2.94	.005	3.0	8.0	7.0	Empirical
Building No. 35 (Concrete-shearwall)	N-S = 0.98 E-W = 1.02	.003	2.25	4.0	4.0	Story Stiffness
Building No. 29 (Concrete-infill wall)	N-S = 1.49 E-W = 1.26	.005	3.0	8.0	7.0	Empirical
Morningside School	Long = 0.10 Trans = 0.15	.001	1.2(Top) 1.0 (Bottom)	1.5	1.5	Empirical

Then using the average building MMI and a table of the type shown in table D.3, one can estimate the percent nonstructural, structural and total damage.

It is noted that Option 2 is presented for the purpose of indicating how one engineer may use the output from the program to estimate damage. That is, if one wishes to use a relationship between damage and building MMI based upon professional experience, one may create a damage estimate. While such individualism is often commendable, it may also be unwise because the formulas used in Option 1 were obtained from a study of considerable historical data.

The correlation between the observed and predicted damage estimates is good. It is noted that the damage estimates reflect the results of only one computer run on each building and are not the results obtained after several iterations aimed at producing an estimate that correlates almost exactly with observed damage. Therefore, the user can expect the same level of accuracy as indicated by the results in table D.4.

C. Tornado Damage Evaluations

The structural and nonstructural damage data available for a tornado natural disaster are very limited. This section performs a damage evaluation of the three buildings noted in section D.5b. These estimates are compared with values cited in [3.39].

Table D.5 presents a summary of the values of the structural input parameters used in this study. Tornado maximum wind speed was set at 200 miles per hour. Table D.6 summarizes the computed and observed damage for each of the three buildings.

D. Hurricane Damage Evaluations

The same buildings noted in section D.5b and table D.6 were also used for the estimation of damage due to a hypothetical hurricane. The hurricane is selected to have a maximum wind speed of 120 miles per hour at a height of 30 feet. All building parameter values are the same as used in the Tornado example, see table D.5.

Since the hurricane evaluation utilizes a hypothetical example there is no observed damage data. Table D.7 presents the predicted percent damage for each building.

Table D.3 DAMAGE ESTIMATES FOR SAN FERNANDO EARTHQUAKE - FEBRUARY 9, 1971

BUILDING	Percent Structural Damage (Av.)			Percent Nonstructural Damage (Av.)			Total % Building Damage (Av.)*			Average Modified Mercalli Intensity For Building
	Computed Option 1	Computed Option 2	Observed Ref[E.1]	Computed Option 1	Computed Option 2	Observed Ref[E.1]	Computed Option 1	Computed Option 2	Observed Ref[E.1]	
Building No. 32	N-S=0.00 E-W=0.00	0.02	0.00	N-S=0.35 E-W=0.36	3.01	0.08	0.27	2.78	0.08	N-S=7.25 E-W=7.27
Building No. 37	N-S=0.00 E-W=0.00	0.00	0.00	N-S=0.16 E-W=0.16	0.84	0.06	0.12	0.84	0.06	N-S=6.59 E-W=6.59
Building No.28	N-S=0.00 E-W=0.00	0.17	0.03	N-S=0.53 E-W=0.38	5.01	0.08	0.34	4.28	1.1	N-S=7.58 E-W=7.30
Building No.35	N-S=0.10 E-W=0.20	0.33	0.0	N-S=2.5 E-W=2.0	8.5	1.00**	1.70	6.4	1.00**	N-S=8.1 E-W=8.2
Building No. 29	N-S=0.28 E-W=0.41	3.18	0.1	N-S=2.03 E-W=2.13	17.77	10.9	1.73	11.73	11.0	N-S=8.74 E-W=8.74
Morningside School	Long=0.0 Trans=0.0	2.6	Ref[E.4] Nominal	Long=12.5 Trans=31.5	19.3	Ref[E.4] Most of the interior plaster on wood lath was loosened. All the lath and plaster has been removed and replaced with drywall.	16.5	15.1	Ref[E.4]	Long=7.8 Trans=8.3

---

* Structural assumed to be 25% and nonstructural 75% of total

** Includes repair cost to air conditioning chiller.

Table D.4 S. B. BARNS & C. PINKHAM'S MEAN DAMAGE ESTIMATES FOR VARIOUS QUALITY FACTORS, Q, SPECIFIED IN TERMS OF SEISMIC DESIGN ZONE

CONCRETE SHEAR WALL

Quality Factor, Q*

MMI	a (g)	V (in/sec)	Non Structural (NST)				Structural (ST)				Total			
			Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4
6	.060	2.03	.03	.028	.013	.025	0	0	0	0	.028	.029	.027	.043
7	.115	4.71	3.13	1.83	1.24	.33	.013	0	0	0	3.02	1.77	1.09	.853
8	.223	10.9	19.3	11.0	7.70	3.2	2.6	.86	.22	.027	12.67	7.9	5.11	2.69
9	.431	25.4	56.6	27.2	12.9	6.83	26.6	6.77	.96	.268	35.67	17.5	7.81	5.35

CONCRETE MOMENT FRAME

Quality Factor, Q

MMI	a (g)	V (in/sec)	Non Structural (NST)				Structural (ST)				Total			
			Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q-3	Q=4
6	.060	2.03	.05	.093	.064	.063	0	0	0	0	.065	.1	.063	.06
7	.115	4.71	4.25	3.37	3.02	2.23	.037	.012	.012	0	3.93	3.4	3.07	2.21
8	.223	10.9	17.73	15.2	10.27	6.48	3.6	1.66	.57	.17	15.37	10.27	7.48	5.3
9	.431	25.4	52	32.37	23.93	17.93	25.47	9.63	5.32	2.13	34.07	27.93	15.22	11.72

*Q=1 (Z=0.25), Q=2 (Z = 0.50), Q=3 (Z = 1.50), Q=4 (Z = 2.00).
Z = seismicity coefficient of zone in which building is located

Table D.4 S. B. BARNES & C. PINKHAM'S MEAN DAMAGE ESTIMATES FOR VARIOUS QUALITY FACTORS (Continued)

STEEL MOMENT FRAME Quality Factor, Q														
			Non Structural (NST)				Structural (ST)				Total			
MMI	a (g)	V (in/sec)	Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4
6	.060	2.03	.109	.058	.052	.046	0	0	0	0	.109	.058	.051	.046
7	.115	4.71	3.47	2.9	2.23	1.61	.01	.003	0	0	3.32	2.88	2.23	1.61
8	.223	10.9	12.17	9.47	6.63	5.5	.87	.404	.121	.111	8.49	6.87	5.35	4.57
9	.431	25.4	32.33	25.17	14.47	11.33	9.4	5.6	1.75	.877	20.85	16.17	9.57	7.18

STEEL BRACED FRAME Quality Factor Q														
			Non Structural (NST)				Structural (ST)				Total			
MMI	a (g)	V (in/sec)	Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4	Q=1	Q=2	Q=3	Q=4
6	.060	2.03	.027	.025	.027	.026	0	0	0	0	.027	.027	.0265	.026
7	.115	4.71	3.53	2.21	1.41	.483	.013	0	0	0	3.38	2.26	1.39	.48
8	.223	10.9	21.67	12.87	7.67	4.18	3.66	1.02	.282	.031	12.42	9.22	5.33	3.78
9	.431	25.4	58.67	43.17	21.6	9.18	28.67	16.67	4.22	.339	38.67	27.67	14.53	6.95

Table D.5 TORNADO AND HURRICANE EXAMPLES

BUILDING	Fundamental Period (Sec)	Interstory Drift to Yield (in/in)
Great Plains Life (Steel)	2.0	.005
First National Bank-Pioneer Gas Company (Concrete)	2.0	.005
Tech Village Apartments (Long span roof)	0.1	.002

Table D.6 TORNADO DAMAGE EVALUATION

BUILDING	Percent Structural Damage		Percent Nonstructural Damage		Total % Building Damage	
	Computed	Observed Ref.[D.5]	Computed	Observed Ref.[D.5]	Computed	Observed Ref.[D.5]
Great Plains Life (Steel)	36.4	----	Partitions: 44.5 Glass: 98.4	Partitions: Many Glass: 27	62.7	50
First National Bank-Pioneer Gas Company (Concrete)	50.5	None	Partitions: 50.3 Glass: 37.0	Partitions: --- Glass: ---	45.4	35
Tech Village Apartments (Long span roof)	Roof Off	Roof Off	Partitions: 3.7 Glass: 94	Partitions: No data given Glass: No data given	Roof Off	Roof Off

Table D.7 HURRICANE DAMAGE EVALUATION

BUILDING	Percent Structural Damage	Percent Nonstructural Damage	Total % Building Damage
Great Plains Life (Steel)	0.0	Partitions: 1.0% Glass: 3.4%	1.7
First National Bank-Pioneer Gas Company (Concrete)	1.25	Partitions: 9.0% Glass: 18.2%	10.7
Tech Village Apartments (Long span roof)	0.05 (Roof On)	Partitions: 2.5% Glass: 1.4%	1.5

APPENDIX E

DETAILED ANALYTICAL EVALUATION METHOD - COMPUTER PROGRAM USERS MANUAL

This appendix contains the User's Manual for the Detailed Analytical Method computer program. The manual is presented as a self-contained document so as to provide the user with a package which may be more conveniently used in the evaluation process. The manual represents the combined efforts of T. K. Hasselman, Richard W. White and Gregg Brandow.

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1.0 PROGRAM DESCRIPTION

The computer program described in this User's Manual provides the basic tools for evaluating potential damage to buildings due to earthquake, wind and tornado. Environmental data are provided along with the program describing the seismic and wind activity for the entire continental United States, Alaska and Hawaii. Historically based tornado activity for the continental United States is included. With these data, the program will compute, in a probabilistic sense, the specific environment of any given building site in the country. Alternatively, the user may choose to input any of these loads directly. For example, an earthquake of Richter magnitude 6.5 at a distance of 10 miles may be input by specifying only those two parameters. The user may also bypass the earthquake loading portion of the program and input directly a ground particle velocity spectra for the site. Damage predictions are made on the basis of the building's response to the appropriate loading conditions. Structural models of varying complexity can be generated depending on the availability of structural data and the level of effort selected for a particular task. Damageability data characterizing the capacity of the building to resist failure must be input by the user. Guidelines are provided in Section 3.4 of the main text of this report. Algorithms for computing damage are based on the assumption that percent damage varies continuously with key response parameters. These key parameters have been selected and are incorporated in the program. The forms of damage distribution curves as functions of response are also built into the program. The user may choose the parameters of these functions in accordance with prepared guidelines and exercise his judgement according to the application at hand.

The computer program is currently operational on the UNIVAC 1108 computer at the National Bureau of Standards and the CDC 3600 computer at the Defense Civil Preparedness agency. Special requirements for the input data for the CDC 3600 are provided at the end of this appendix.

A more detailed discussion of the program is given in the paragraphs which follow. Flow diagrams are included at the end of this section which illustrate the top and secondary levels of program organization. Detailed input preparation is explained in Section 2.0 and a discussion of the printed output is included in Section 3.0.

The entire program is organized in modular form. This tends to provide a simple framework for understanding the program and offers flexibility for subsequent updating anticipated as the result of user experience. Considerable effort has been made to maintain clean interfaces among the different modules to facilitate maintenance and avoid repetitive operations and unnecessary data handling. The overall flow of information within the program is shown in flow Diagram 1. The four major parts of the program include:

1) the generation of site loads
2) the generation of a structural model
3) computation of response, and
4) assessment of damage.

Subroutine LØADS constitutes the first part, STRUCT the second, DYNAMC, STATIC and LSRØØF the third, and DAMAG the fourth. As shown in the flow diagram, operations proceed in that order. Options are provided to allow consideration of the three environmental hazards singly or in combination.

Damage to longspan roofs is treated independently of structure related damage as discussed in Section 1.3 of this Appendix and Chapter 3 (Section 3.4 I) of the main text.

1.1 Loads

The LØADS subroutine, Flow Diagram 2, calls four other subroutines, depending on the hazard options selected. The options are:

NHAZ(1) = 0: bypass earthquake loads
≠ 0: generate earthquake loads

NHAZ(2) = 0: bypass wind loads
≠ 0: generate wind loads

NHAZ(3) = 0: bypass tornado loads
≠ 0: generate tornado loads

Site loads for earthquake are defined by a ground site response spectrum. This response spectrum reflects an amplification of the hard-rock spectrum for the site, which is frequency dependent. The hard-rock spectrum is generated in Subroutine SEISMC. This is done in either of two ways (See Section 2.1.1.1 and Chapter 3 of the main text). If the risk option is selected, LRISK ≠ 0, the user must input seismicity data from the Seismic Map provided with the program. By further specifying either a return period or building life and probability of nonoccurrence, a risk earthquake defined by its Richter magnitude EM is computed. If LRISK = 0, the risk option is bypassed and the user must input a magnitude EM and hypocentral distance RBAR. In either case, hard-rock acceleration, velocity and displacement characteristics are computed and transmitted to Subroutine SØILØD.

A soil model is generated in SØILØD as a basis for determining soil amplification of the hard-rock ground motion. Four basic modeling options are provided ranging from a complex model requiring detailed soils data to a simple model requiring only standard geological soil characterization (See Section 2.1.1.2 and Section 3.4 of the main text. A dynamic amplification factor $(DAF)_s$ for the soil is computed as a function of frequency (or period). A hard-rock spectrum is generated from the acceleration, velocity and displacement characteristics computed in SEISMIC and then multiplied by $(DAF)_s$ to generate the ground site spectrum. The procedure for directly inputting a ground particle velocity spectra is discussed in Section 2.1.1.3.

If NHAZ(2) ≠ 0, a wind velocity is generated for the specified site (see Section 2.1.2). If ITEST = 1, a statistical regression analysis is used to compute a mean wind velocity given either a return period or building life and probability of nonoccurrence. A standard deviation is also computed and may be used to establish some degree of confidence in the wind velocity selected for analysis. If ITEST = 2, the user must input a wind velocity for analysis. As in the case of earthquakes, local site conditions modify the wind velocity which is determined on the basis of historical data. For example, free-field wind velocities in large cities are attenuated by the presence of buildings, whereas, on an open prairie, the attenuation is comparatively small. Thus, in figuring the wind load on a building, surface conditions are accounted for by specifying the parameter ISITE as described in Section 2.1.2.

If NHAZ(3) ≠ 0, the probability of being hit by a tornado is computed from map data giving the mean annual frequency of tornados. In addition, the user may specify a tornado wind velocity by setting ITØR ≠ 0 and inputting a velocity VT as explained in Section 2.1.3. In this case, the static response of the building will be computed and damage assessments made.

1.2 Structural Model

Subroutine STRUCT (Flow Diagram 3) accepts structural modeling data and generates a model of the structure for subsequent response analysis. Dynamic characteristics are either input or computed by this subroutine. Three modeling options are provided:

NM0D = 1: Detailed frame model

NM0D = 2: Story stiffness model

NM0D = 3: Empirical model

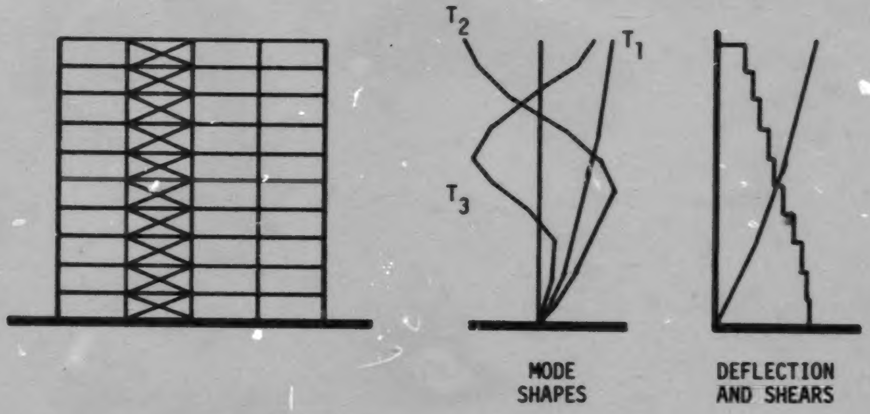
Sketches of these modeling configurations are included in Figures 1 through 3 to illustrate the scope of model complexity.

If the user selects NM0D = 1, STRUCT calls STIFF1 which is used to generate a detailed stiffness matrix for the structure (See Section 2.2.1). The stiffness matrix is constructed frame by frame, story by story, from top to bottom. Coordinate numbering conventions are shown in Figure 4. As shown in Flow Diagram 4, the user must first input a value for NFRMS which specifies the number of frames to be used in the model. Each frame is parallel to the direction of motion in a vertical plane. Stiffness and mass contributions from each frame are superposed in formulating the two-dimensional model of a building. The user may choose between two frame modeling options:

N0PT = 1: Steel frame model (SFRAME)

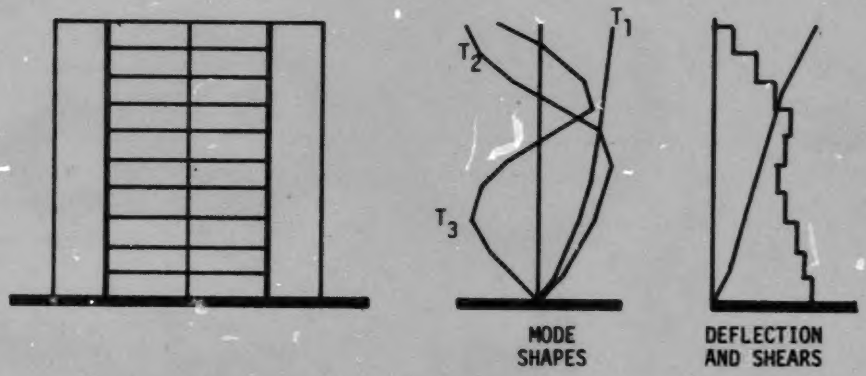
N0PT = 2: General frame model (GFRAME)

The steel frame model is most convenient to use for steel frame structures because standard framing members may be


T2
T1
T3
MODE SHAPES
DEFLECTION AND SHEARS

NØPT = 1

(Steel Frame Model)


T1
T2
T3
MODE SHAPES
DEFLECTION AND SHEARS

NØPT = 2

(General Frame Model)

Figure 1. NMOD = 1 Detailed Frame Model Options

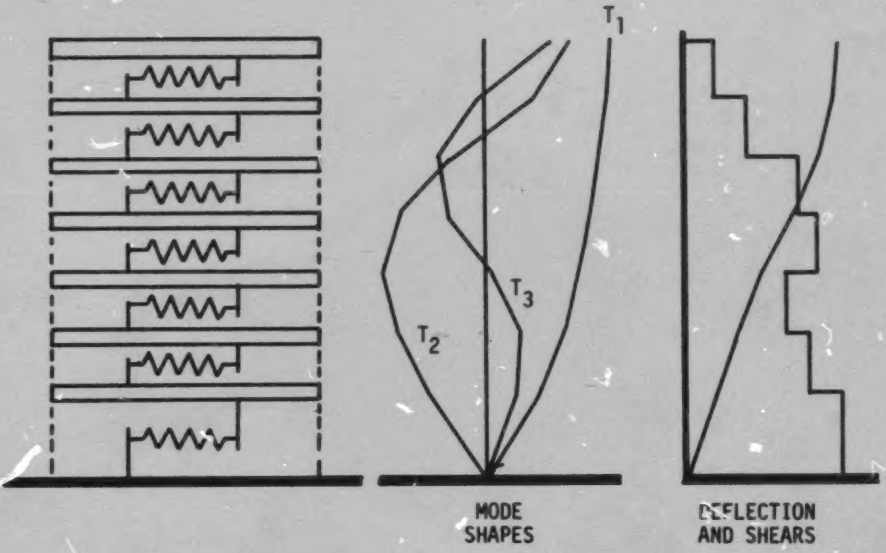

T_1
T_3
T_2
MODE SHAPES
DEFLECTION AND SHEARS

Figure 2. NMOD = 2 Story Stiffness Model

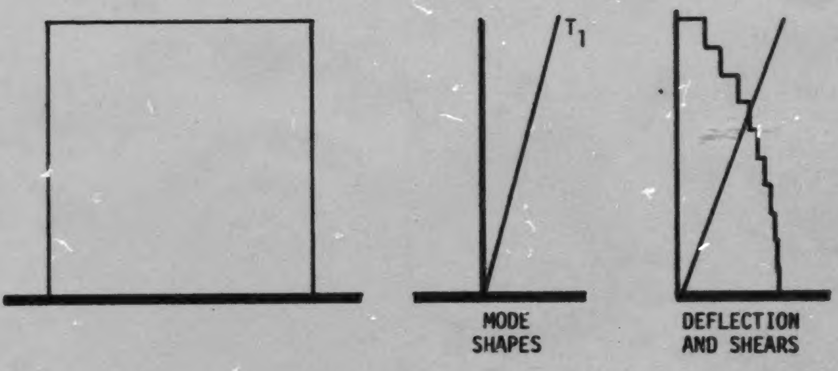

T_1
MODE SHAPES
DEFLECTION AND SHEARS

Figure 3. NMOD = 3 Empirical Model

REMARKS:

1. BEAMS, COLUMNS, AND JOINT LOCATIONS AT EACH FLOOR ARE NUMBERED FROM LEFT TO RIGHT, STARTING WITH 1.
2. STORIES ARE NUMBERED FROM TOP TO BOTTOM.

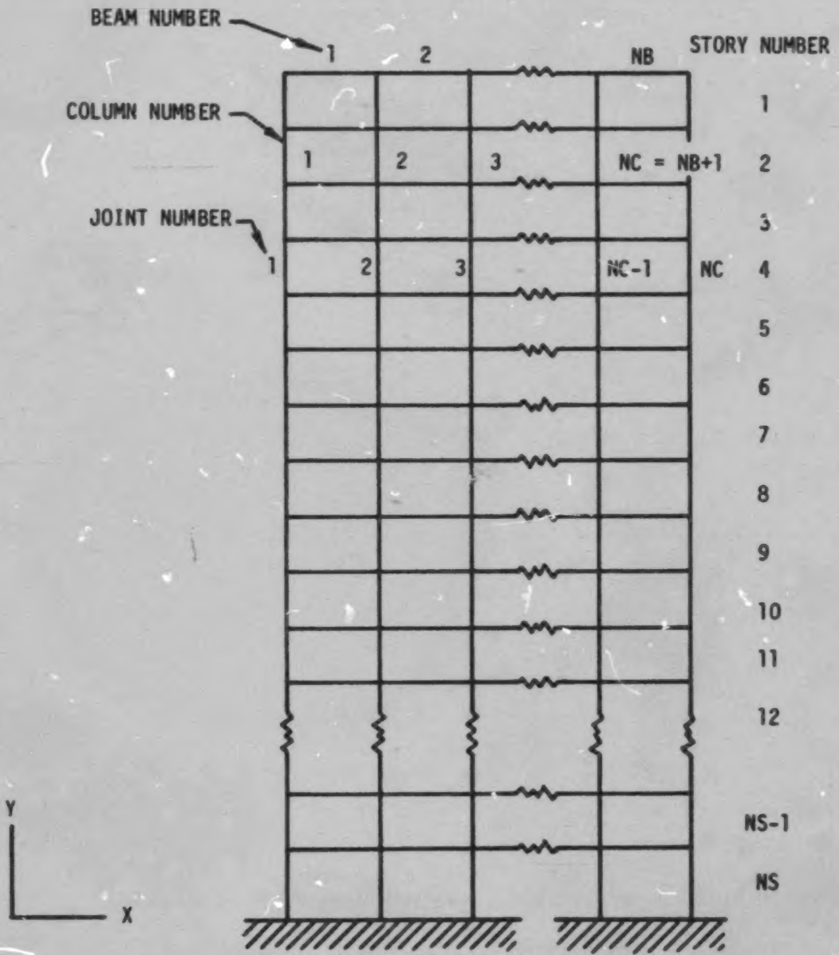

BEAM NUMBER
1
2
NB
STORY NUMBER
COLUMN NUMBER
1
2
3
NC = NB+1
JOINT NUMBER
1
2
3
NC-1
NC
1
2
3
4
5
6
7
8
9
10
11
12
NS-1
NS
Y
X

Figure 4. Numbering Conventions

specified by code rather than having to enter detailed section properties. In addition, it offers the capability for including non-rigid joints. The general frame model is intended primarily for concrete frame and shearwall type structures, although it could be used for steel frame structures as well. This option must be used to model frames with shearwalls since NOPT = 1 offers no shearwall modeling capability. (See Section 2.2.1).

Although it is not shown explicitly in Flow Diagram 4, SFRAME or GFRAME, CONDEN and FRMASS are called once for each story of the model. CONDEN operate on the detailed stiffness matrix generated for the current story and condenses it into a reduced stiffness matrix corresponding to floor translations for the current story and all of those above it. If no dead load for framing is to be included in the final mass matrix, the user may set NDLC = 1 and FRMASS, the subroutine which lumps framing mass at each floor, is bypassed.

If NFRMS >1, stiffness matrices for additional frames are generated and superposed, i.e. the frames act in a parallel configuration. NOPT may be reset so that a mixture of SFRAME and GFRAME models can be combined. When the frame counter reaches NFRMS, control is returned to STRUCT.

If the user specifies NMOD = 2, STRUCT calls STIFF2 which reads story stiffness and story height data as described in Section 2.2.2. As with NMOD = 1, an NS x NS stiffness matrix is created.

Floor mass is added to framing mass (if any) by calling subroutine FLMASS. This subroutine reads floor weights in KIPS, converts to mass and adds them to a mass vector, which, in the case of NMOD = 1, may contain framing mass already. The lumped mass model is shown in Figure 5. After forming the total mass vector for either NM0D = 1 or 2, subroutine EIGENS is called to compute modal deflections and frequencies.

If NM0D = 3, STIFF3 is called and an empirical model is generated. A fundamental period and story heights are read as discussed in Section 2.2.3. A straight-line mode shape is assumed to compute deflections. FLMASS is called to read in floor weights but EIGENS is, of course, bypassed.

1.3 Response

The site loads generated in L0ADS and the structural characteristics generated in STRUCT are used in this part of the program to determine structural response to the site environments. Response computations are made in DYNAMC for earthquake loads, in STATIC for wind and tornado loads, and in LSR00F for uplift due to wind. Ponding loads are also computed in LSR00F.

The response of a building to earthquake ground motion is evaluated by determining the peak modal response in each of the modes (a maximum of six is considered), and combining their contributions to the total response in some fashion.

Inputs to DYNAMC are explained in Section 2.2.3 and include a damping code, a ductility code, a modal combination code and story drift-to-yield used to compute an effective ductility μ for the building. Since damping is defined as a function

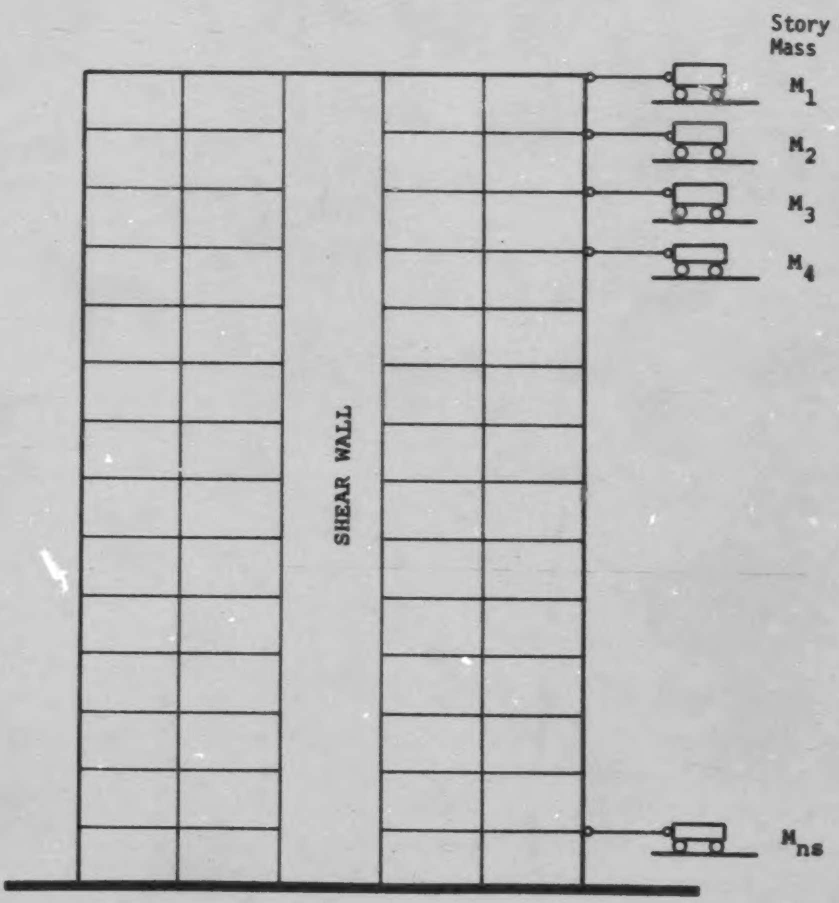

Story Mass
M1
M2
M3
M4
SHEAR WALL
Mns

Figure 5. Lumped Mass Model

of μ, and μ is response dependent, an iterative procedure must be used to establish consistent values of damping and response. While this operation seems to be stable and typically converges in a few cycles (three or four), an upper limit (e.g. six) on the number of iterations, ITERMX, is input and used to transfer control out of the iterative loop in case the computations do not converge to within 5%. This may only occur when elasto-plastic response is considered as discussed below.

Two damping options (See Section 3.4 of the main text are available by specifying appropriate values of the variable NDAMP. If NDAMP = 1 the nominal damping curve is used which is applicable to steel frame and reinforced concrete structures. In this case, modal damping ranges from about 2% for $\mu = 0$ up to about 10% for a μ of 3.5. If NDAMP = 2, these values are doubled. NDAMP = 2 is intended to be used for bolted or riveted steel frames, or timber structures.

An effective ductility μ is defined as

$$\mu = \sqrt{E/E_y}$$

where E_y is the maximum energy storage capacity of the structure in the state of uniform incipient yielding, and E is the (hypothetical) strain energy which would be stored if the structure were assumed to remain elastic for the linear response computed. If the computed response is sufficiently large that $\mu > 1$, then by setting LD $\neq$ 0, the response of the structure is altered to reflect some of the effects of yielding. These operations are performed by subroutine SPECTR.

Four operations in all are performed in SPECTR:

1) Increase modal period if $\mu > 1$ and LD $\neq 0$.
2) Interpolate between points defined for the ground site spectrum to compute a spectral velocity, SV.
3) Form an amplification factor $(AF)_\zeta$ to account for structural damping and multiply $(AF)_\zeta \times SV$.
4) Form a second amplification factor $(AF)_\mu$ to account for ductility and multiply $(AF)_\mu \times (AF)_\zeta \times SV$, (LD $\neq 0$ only). Actually, two different values of $(AF)_\mu$ are computed. One is used to obtain a final spectral velocity SVF for use in computing forces or accelerations and the other is used to obtain a final spectral velocity SVD for computing displacements and velocities.

Thus

$$SVF = (AF)_\mu^F \times (AF)_\zeta \times SV$$

$$SVD = (AF)_\mu^D \times (AF)_\zeta \times SV$$

Referring back to Flow Diagram 5, one may now follow the entire sequence of operations. It is seen that the total response is computed in an iterative manner until the values of μ and ζ converge (or the iteration counter reaches ITERMX).

In computing total response, one of three options is available:

MCOP = 1: First mode response only
MCOP = 2: RSS of first six modes
MCOP = 3: Absolute sum of first six modes.

Interstory drift, pseudo-velocity, and absolute acceleration are computed for each story and passed through the call statements to subroutine DAMAG. In addition, story forces and shears are computed for all three options and are printed for comparative purposes only, unless N0PRT = 1. These latter quantities are not used in damage evaluation.

Structural response to wind (and tornado if IT0R = 1) is evaluated in subroutine STATIC (Flow Diagram 6). The stiffness matrix is first inverted if NM0D ≠ 3. Either of subroutines WIND or TRNAD0 is then called to compute a distribution of pressure forces for the building. Data input required by WIND is covered in Section 2.3.2. No data are input for TRNAD0. For either NM0D = 1 or 2, the inverted stiffness matrix is used to compute deflection of the building. If NM0D = 3, an alternative method is used as discussed in Section 3.4 of the main text.

Only two simple failure modes are considered for long-span roofs. These are separation due to excessive uplift forces or collapse due to excessive ponding. Response is a binary quantity in either case, fail or no fail, and is determined by whether the respective forces exceed or do not exceed the total vertical support capacity in the upward direction or the capacity of the roof structure in the downward direction. Thus, most of the computation is devoted to determining the forces which are configuration dependent and are included in the response part of the program rather than the loads part. Three alternative methods are provided for computing uplift as indicated in Section 2.3.3. Each of these options is explained in Section 3.4 of the main text.

Potential roof damage to any building may be evaluated for the two modes of failure mentioned above. The intent, however, is that long-span roofs will be of main concern since larger uplift forces are developed for longer spans and adequate support is more difficult to achieve. Ponding is not likely to create excessive loading for short-span roofs and, of course, will not occur with proper drainage.

1.4 Damage

Potential damage to a building which may result from exposure to the environmental loads computed for the building site, is evaluated in Subroutine DAMAG (Flow Diagram 8). Damage is expressed in percent of total damage on a story by story basis. Damage is computed independently for earthquake, wind and tornado. It is segregated into three categories: structural, nonstructural and glass. In the case of structural damage, the damage is further subdivided into damage to frame, walls, and diaphragms.

The key response parameters used to predict damage in each case are outlined below.

1. Earthquake
    - a. Structural: interstory drift
    - b. Nonstructural: floor velocity or acceleration
    - c. Glass: interstory drift
2. Wind or Tornado
    - a. Structural: interstory drift
    - b. Partitions: interstory drift
    - c. Glass: direct pressure

For earthquake, nonstructural damage includes partitions as well as other types of nonstructural damage. With the exception of nonstructural damage due to earthquake, damage is computed by comparing the key response parameter to a strength capacity characterized by a nominal value and a dispersion parameter (coefficient of variation) which are specified by the user (See Section 3.4 of the main text of this report.) Thus damage is considered to vary in a continuous manner with response level. Although a probabilistic interpretation of the distribution functions is plausible and has some appeal, it is not essential. Thus, some of the conceptual obstacles which arise in trying to justify a particular function, which happens to follow from certain well-defined statistical phenomena, may be avoided. The salient feature of the damageability curves used in this program is their ability to represent the tendency for percent damage to increase monotonically (i.e. in a non-decreasing manner) with response level. As stated at the outset, it is deemed to be the user's responsibility to select capacity distribution parameters to fit a particular situation.

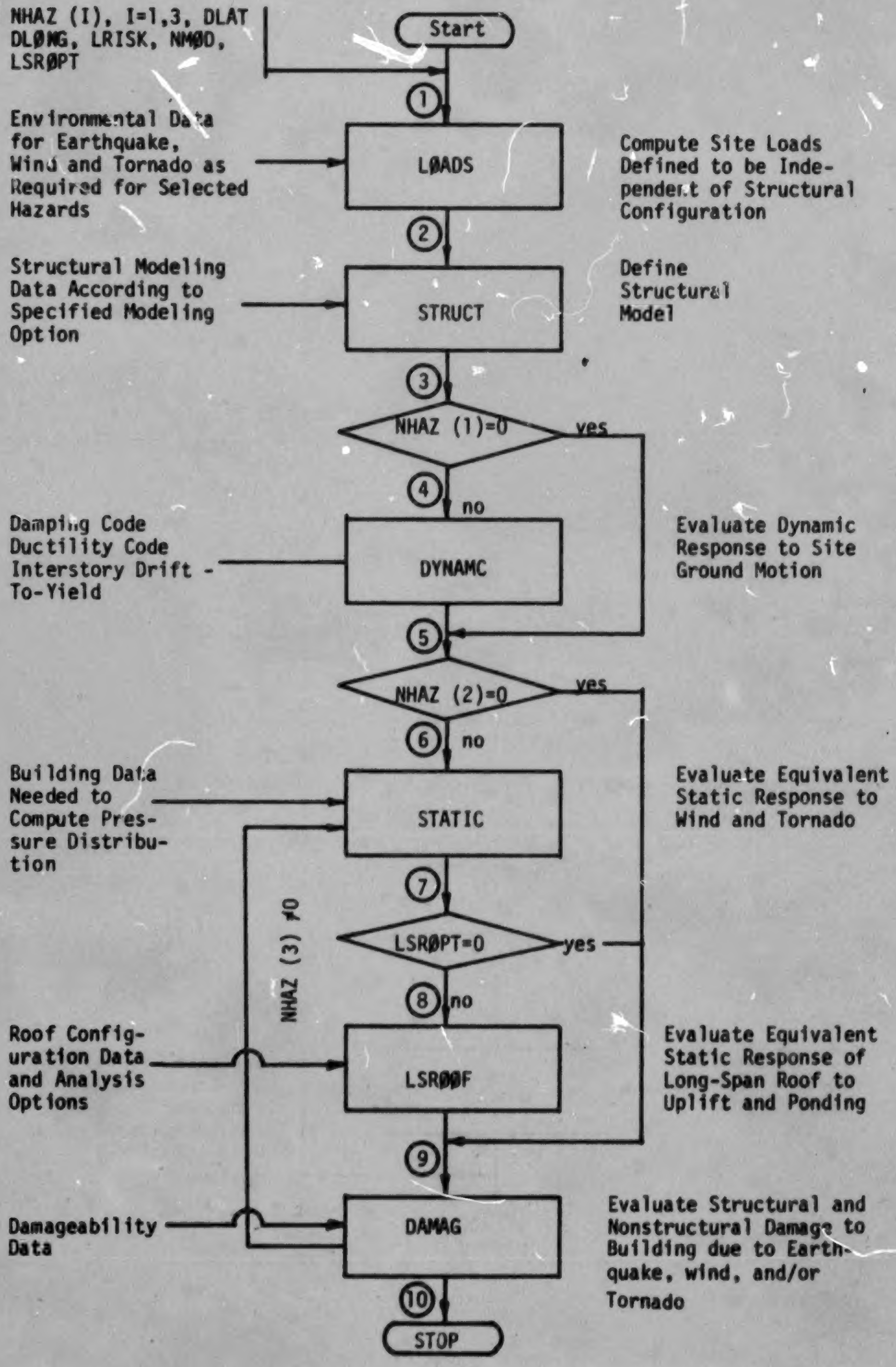
In computing nonstructural damage due to earthquake, percent of component damage is computed on the basis of a Modified Mercalli Intensity (MMI) as discussed Section 3.4 of the main text. Values for MMI at each story are computed form both floor acceleration and velocity and the largest of these is used to compare percent damage.

Damage to long-span roof is considered to be either zero or 100%, corresponding to the fail/no-fail response parameters. Appropriate statements are printed out by DAMAG.

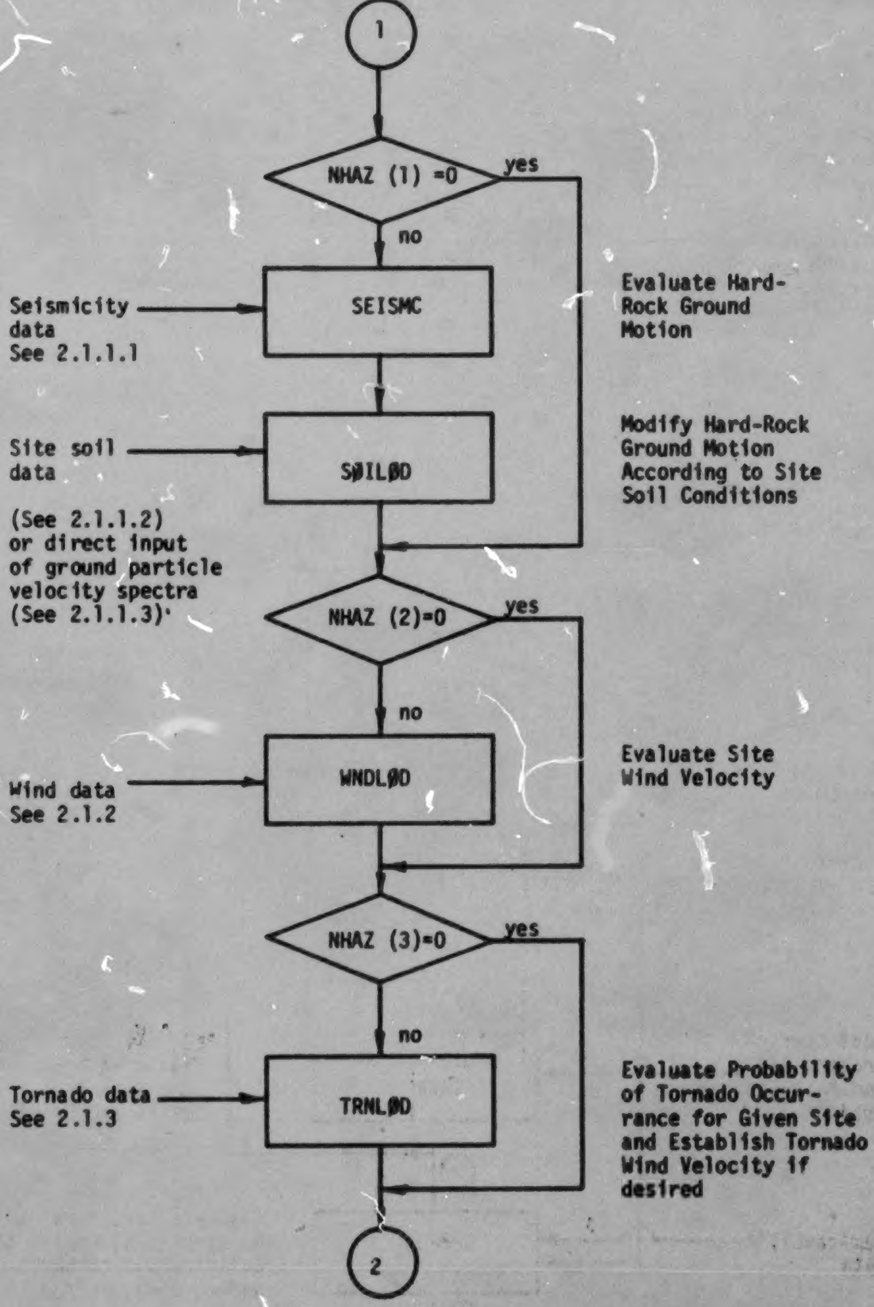
In computing tornado damage, the program cycles through DAMAG once, and then goes back to STATIC, computes pressure forces and drift for tornado and then calls DAMAG a second time. Thus, while the pressure forces and drift are different for tornado than they are for wind, the same damage algorithms and damageability data are used.

1.5 Flow Diagrams

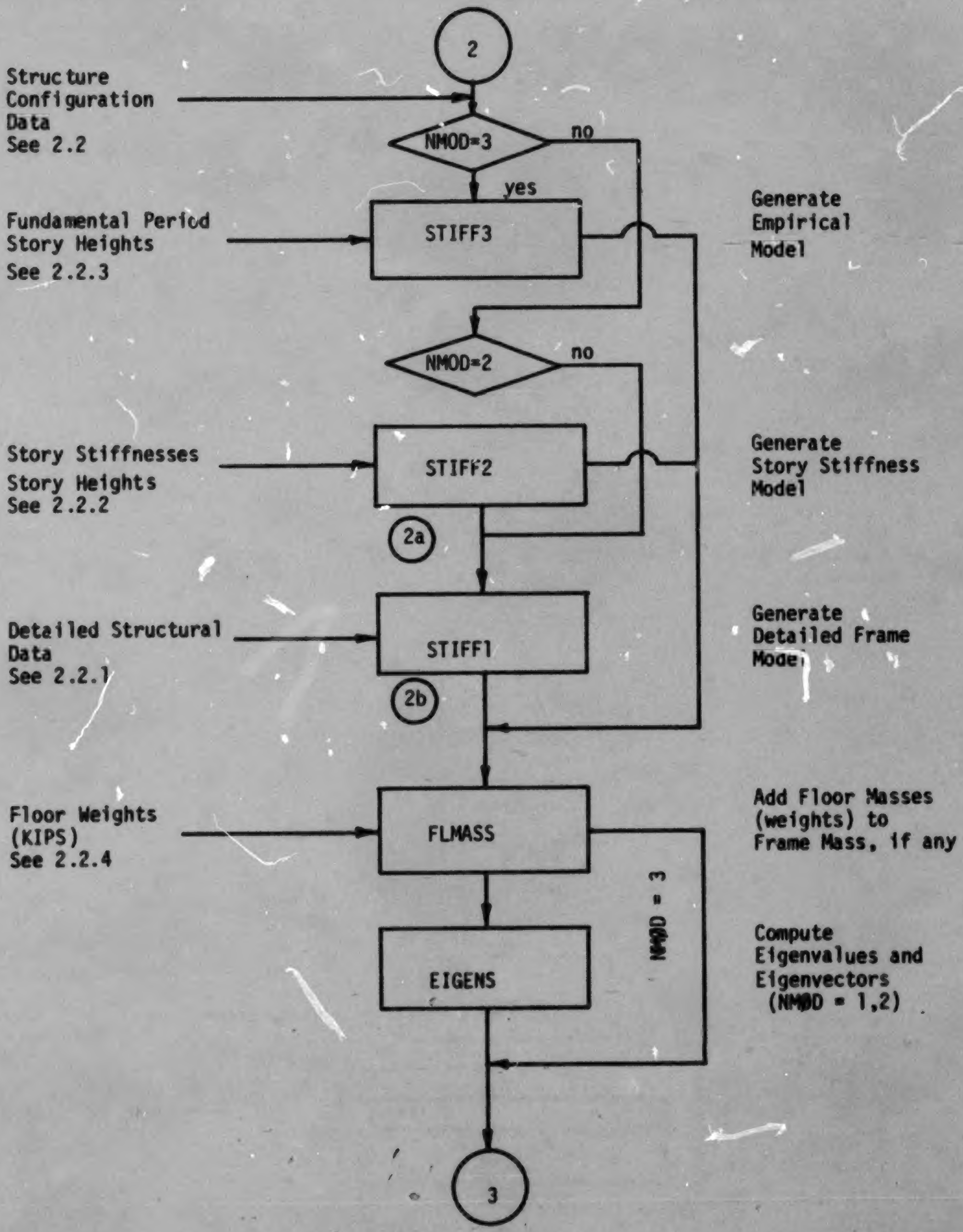
Flow Diagram 1. MAIN Program


NHAZ (I), I=1,3, DLAT DLONG, LRISK, NMOD, LSROPT
Start
①
Environmental Data for Earthquake, Wind and Tornado as Required for Selected Hazards
LOADS
Compute Site Loads Defined to be Independent of Structural Configuration
②
Structural Modeling Data According to Specified Modeling Option
STRUCT
Define Structural Model
③
NHAZ (1)=0
yes
④
no
Damping Code Ductility Code Interstory Drift - To-Yield
DYNAMC
Evaluate Dynamic Response to Site Ground Motion
⑤
NHAZ (2)=0
yes
⑥
no
Building Data Needed to Compute Pressure Distribution
STATIC
Evaluate Equivalent Static Response to Wind and Tornado
⑦
NHAZ (3) ≠0
LSROPT=0
yes
⑧
no
Roof Configuration Data and Analysis Options
LSROOF
Evaluate Equivalent Static Response of Long-Span Roof to Uplift and Ponding
⑨
Damageability Data
DAMAG
Evaluate Structural and Nonstructural Damage to Building due to Earthquake, wind, and/or Tornado
⑩
STOP

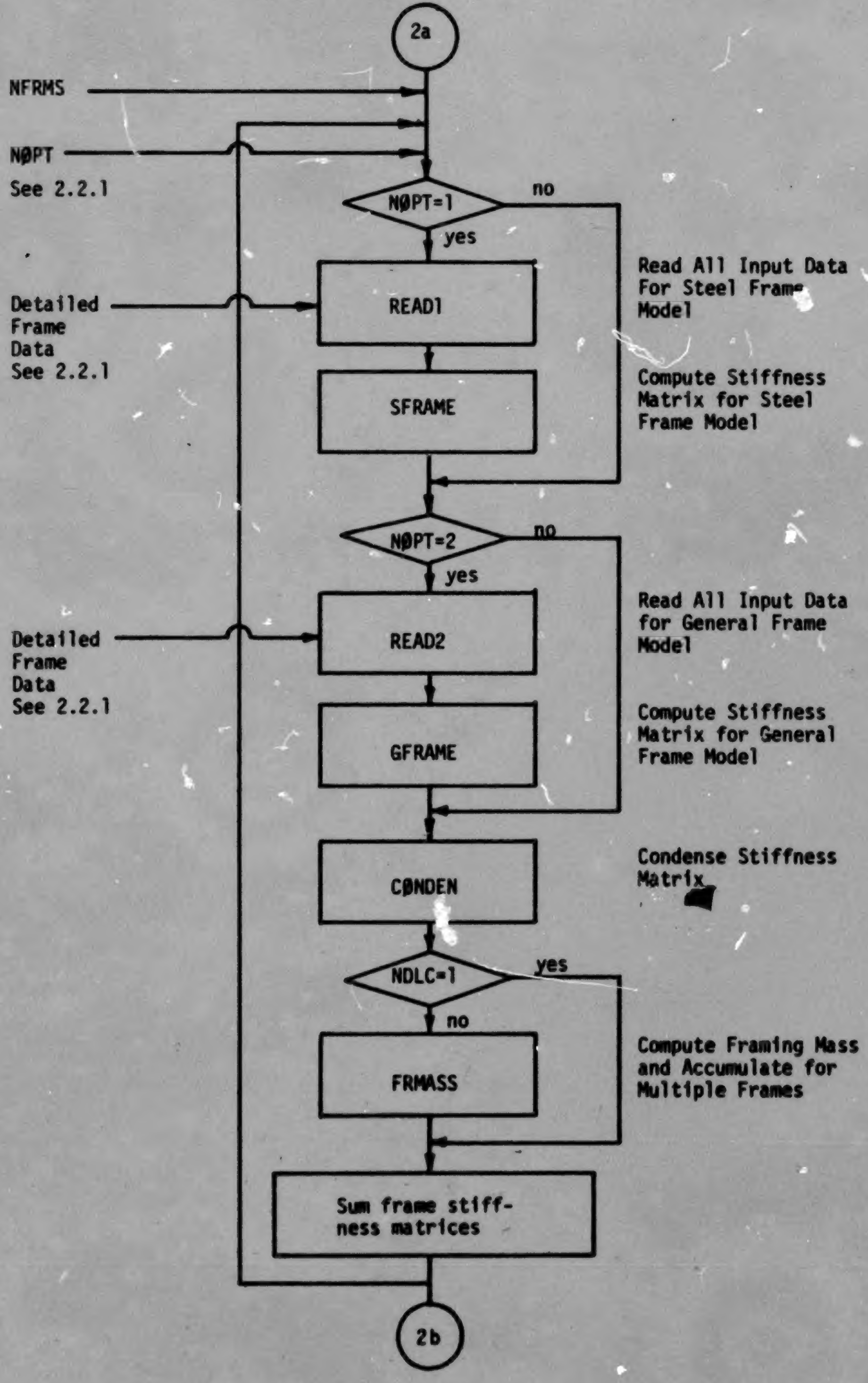
Flow Diagram 2. Subroutine LOADS


1
NHAZ (1) =0
yes
no
Seismicity data See 2.1.1.1
SEISMC
Evaluate Hard-Rock Ground Motion
Site soil data
SOILOD
(See 2.1.1.2) or direct input of ground particle velocity spectra (See 2.1.1.3)
Modify Hard-Rock Ground Motion According to Site Soil Conditions
NHAZ (2)=0
yes
no
Wind data See 2.1.2
WNDLOD
Evaluate Site Wind Velocity
NHAZ (3)=0
yes
no
Tornado data See 2.1.3
TRNLOD
Evaluate Probability of Tornado Occurrance for Given Site and Establish Tornado Wind Velocity if desired
2

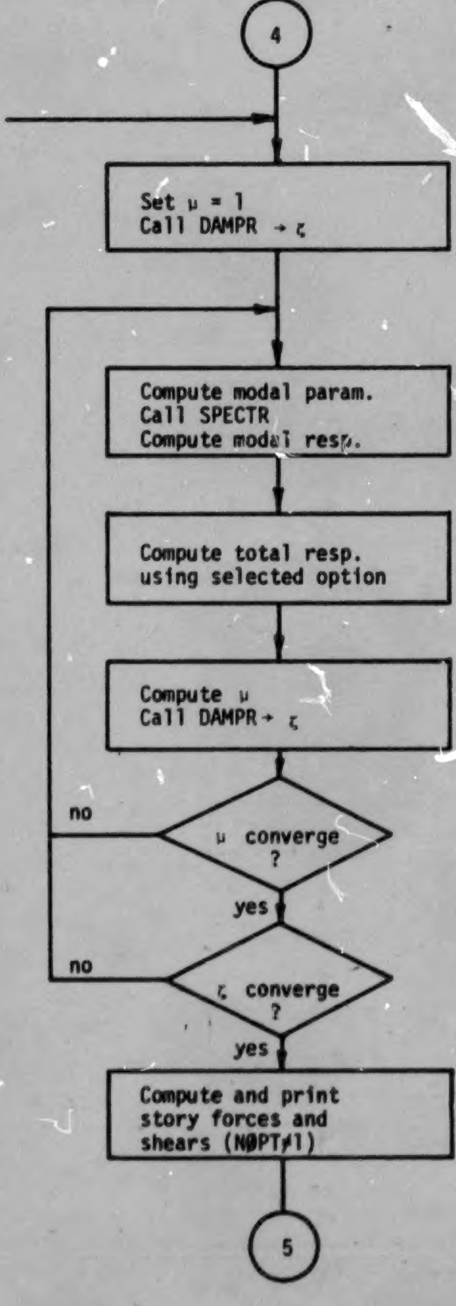
Flow Diagram 3. Subroutine STRUCT


2
Structure
Configuration
Data
See 2.2
NMOD=3
no
yes
Fundamental Period
Story Heights
See 2.2.3
STIFF3
Generate
Empirical
Model
NMOD=2
no
Story Stiffnesses
Story Heights
See 2.2.2
STIFF2
Generate
Story Stiffness
Model
2a
Detailed Structural
Data
See 2.2.1
STIFF1
Generate
Detailed Frame
Model
2b
Floor Weights
(KIPS)
See 2.2.4
FLMASS
Add Floor Masses
(weights) to
Frame Mass, if any
NMOD = 3
EIGENS
Compute
Eigenvalues and
Eigenvectors
(NMOD = 1,2)
3

Flow Diagram 4. Subroutine STIFF1


2a
NFRMS
NØPT
See 2.2.1
NØPT=1
no
yes
Detailed Frame Data See 2.2.1
READ1
Read All Input Data For Steel Frame Model
SFRAME
Compute Stiffness Matrix for Steel Frame Model
NØPT=2
no
yes
Detailed Frame Data See 2.2.1
READ2
Read All Input Data for General Frame Model
GFRAME
Compute Stiffness Matrix for General Frame Model
CØNDEN
Condense Stiffness Matrix
NDLC=1
yes
no
FRMASS
Compute Framing Mass and Accumulate for Multiple Frames
Sum frame stiffness matrices
2b

Flow Diagram 5. Subroutine DYNAMC

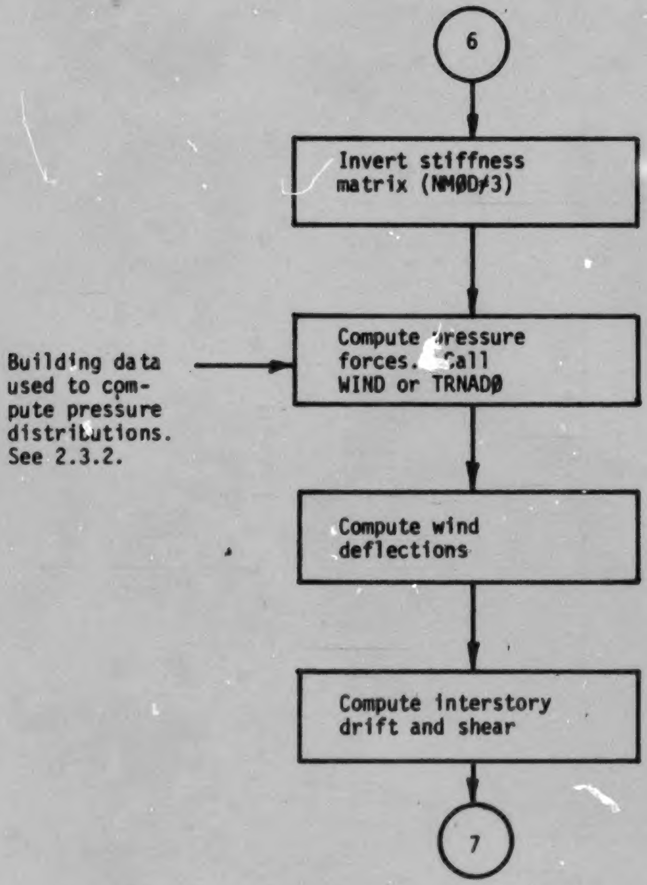

4
Set μ = 1
Call DAMPR → ζ
Compute modal param.
Call SPECTR
Compute modal resp.
Compute total resp.
using selected option
Compute μ
Call DAMPR → ζ
no
μ converge ?
yes
no
ζ converge ?
yes
Compute and print
story forces and
shears (NOPT≠1)
5

Damping Code
Ductility Code
Iteration Limit
Modal Combination Code
Drift-to-Yield
See 2.3.1

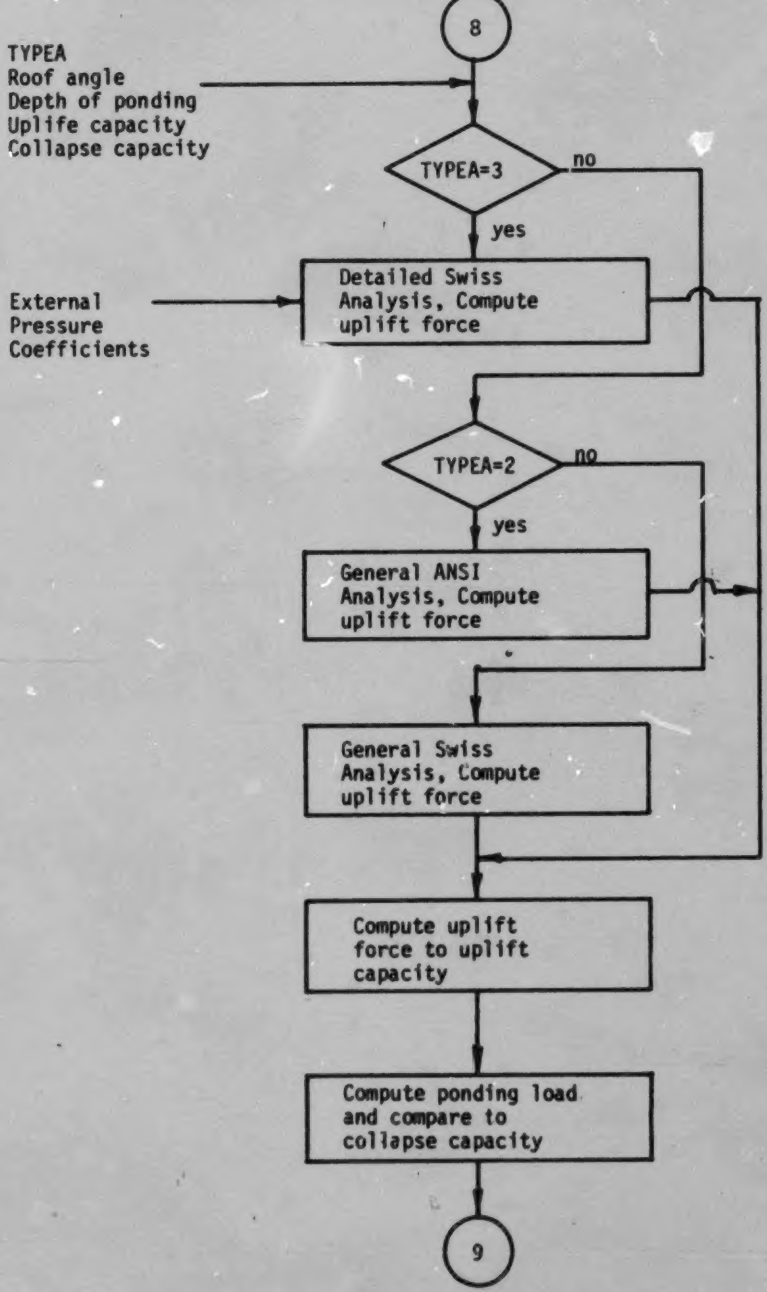
μ = Effective Ductility
ζ = Critical Damping Ratio
DAMPR Computes
ζ = f(μ)

SPECTR Interpolates Site Ground Spectrum and Amplifies for Structural Damping (and Ductility, if desired)

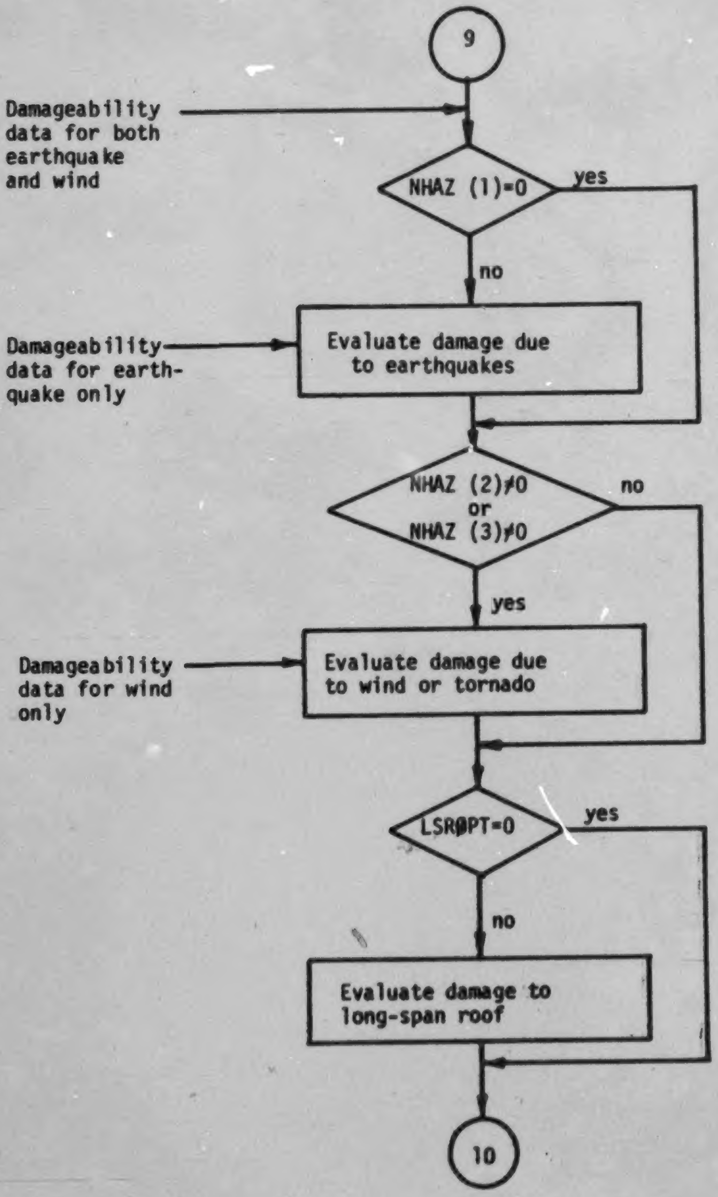
Flow Diagram 6. Subroutine STATIC


6
Invert stiffness matrix (NM0D≠3)
Compute pressure forces. Call WIND or TRNAD0
Building data used to compute pressure distributions. See 2.3.2.
Compute wind deflections
Compute interstory drift and shear
7

Flow Diagram 7. Subroutine LSR00F


8
TYPEA
Roof angle
Depth of ponding
Uplife capacity
Collapse capacity
TYPEA=3
no
yes
External
Pressure
Coefficients
Detailed Swiss
Analysis, Compute
uplift force
TYPEA=2
no
yes
General ANSI
Analysis, Compute
uplift force
General Swiss
Analysis, Compute
uplift force
Compute uplift
force to uplift
capacity
Compute ponding load
and compare to
collapse capacity
9

Flow Diagram 8. Subroutine DAMAG


9
Damageability data for both earthquake and wind
NHAZ (1)=0
yes
no
Damageability data for earthquake only
Evaluate damage due to earthquakes
NHAZ (2)≠0 or NHAZ (3)≠0
no
yes
Damageability data for wind only
Evaluate damage due to wind or tornado
LSRØPT=0
yes
no
Evaluate damage to long-span roof
10

1.6 Capacity

The following restrictions apply to each two-dimensional frame generated; none of the restrictions may be exceeded:

Number of stories	30
Number of bays	9
Beam section types	99
Column section types	99
Total number of beams	200
Total number of columns	200

There is no limit to the number of frames which may be generated.

Stiffness matrices of framed structures are usually well conditioned and round-off error is rarely a problem. The program basically works in single precision arithmetic; therefore, care should be taken when members with very large relative stiffnesses are used. A good rule of thumb is to avoid the use of relative stiffness ratios greater than 10^4. Numerical problems can occur in both matrix equation solving subroutines and the eigenproblem subroutine if an ill-conditioned problem is formulated.

2.0 INPUT PREPARATION

Input is free form;* that is, each card is identified by its logical sequence in the input stream (no card identification code is included), and each *field within a card is delimited* by commas and identified by its sequence within the card. Any omitted fields are identified by two adjacent commas, i.e. n adjacent commas signify n-1 adjacent fields which are omitted. Data entered in vector form, e.g. VEL(I), I=1, NPTS as shown in Section 2.1.2, are entered in consecutive fields on one card or more as required. Numerical values must be input in either integer or floating point format as indicated by I or F. All units are in KIPS, INCHES and SECONDS except as noted.

The data for a computer run must be organized in the sequence described in the following paragraphs.

Input to Program MAIN

Card	No. of Cards	Input Variables
A	1	TITLE
B	1	NHAZ (I), I = 1,3
C	1	DLAT, DLØNG
D	1	LRISK, NMØD, LSRØPT

A: Title Card - Up to 72 characters beginning in Column 1.

B: Hazards Option Card

Field No.	Symbolic Code	Description of Contents
1 I	NHAZ(1)	≠ 0 Consider earthquake
2 I	NHAZ(2)	≠ 0 Consider wind
3 I	NHAZ(3)	≠ 0 Consider tornado

---

*Free form input may not be used on the CDC-3600 computer. A special version of the program is available for this machine. See Appendix.

C: Site Location

Site location is specified by reading in latitude and longitude relative to standard global coordinates.

Field No.	Symbolic Code	Description of Contents
1 F	DLAT	North Latitude
2 F	DLONG	West Longitude

D: Program Control Options

Field No.	Symbolic Code	Description of Contents
1 I	LRISK	≠ 0 Exercise risk option for earthquake
2 I	NMØD	Structural Modeling Option = 1 Detailed Frame = 2 Story Stiffness = 3 Empirical
3 I	LSRØPT	≠ 0 Evaluate damage to long-span roof

2.1 Loads

2.1.1 Earthquake (See Section 3.4 of the main text.)

2.1.1.1 Input to Subroutine SEISMC

Card	No. of Cards	Input Variables
A	1	EM, RBAR (LRISK = 0)
B	1	LP (LRISK ≠ 0)
C	1	RNI (LP = 0)
D	1	BLIFE, PNØC (LP ≠ 0)
E	1	A, ASIG, RBAR
F	1	ENSIG, EMMAX
G	1	LCØP
H	1	C1, C2, C3 (LCOP ≠ 0)
I	1	CA1, CA2
J	1	CD1, CD2

A: Deterministic Earthquake (LRISK = 0)

Field No.	Symbolic Code	Description of Contents
1 F	EM	Richter Magnitude for deterministic earthquake
2 F	RBAR	Hypocentral distance from building site to earthquake source (miles)

B: Life and Probability Option (LRISK ≠ 0)

Field No.	Symbolic Code	Description of Contents
1 I	LP	= 0 : User input return period ≠ 0 : User input life and probability of non-occurrence

C: Return Period (LRISK ≠ 0, LP = 0)

Field No.	Symbolic Code	Description of Contents
1 F	RNI	Return period in years

D: Life and Probability (LRISK ≠ 0, LP ≠ 0)

Field No.	Symbolic Code	Description of Contents
1 F	BLIFE	Life expectancy of building in years
2 F	PNØC	Desired probability that an earthquake of computed magnitude or greater will not occur during a period of BLIFE.

E: Seismicity Data ($LRISK \neq 0$)

Field No.	Symbolic Code	Description of Contents
1 F	A	Seismicity obtained from map for specified Location
2 F	ASIG	Standard deviation of A also from map
3 F	RBAR	Effective hypocentral distance of risk earthquake (miles)

F: Parameters for Specifying Risk Earthquake (See Section 3.4 of the main text.) of Magnitude EM

$$EM = \begin{cases} M = 1/.9 \left[(A + ENSIG*ASIG) - \log_{10} N\right] & : M < EMMAX \\ EMMAX & : M \geq EMMAX \end{cases}$$

where

$$N = \begin{cases} 1/RNI & : LP = 0 \\ -\ln(PN0C)/BLIFE & : LP \neq 0 \end{cases}$$

Field No.	Symbolic Code	Description of Contents
1 F	ENSIG	Number of standard deviations above mean seismicity used to determine Engineering Seismicity
2 F	EMMAX	User imposed upper limit on magnitude of Risk Earthquake

G: Input Option

Field No.	Symbolic Code	Description of Contents
1 I	LCØP	= 0 Use internal constants for computing hard rock ground motion from EM and RBAR ≠ 0 User supply constants if available from independent source

H: Velocity Constants (LCØP ≠ 0)

If LCØP = 0, the user must input constants to be used in computing hard-rock ground velocity from the formula

$$V_r = C1 \times 10^{C2(EM)} \times RBAR^{-(C3)}$$

These may be computed independently by the user based on regression analysis if data are available (See Section 3.4 of the main text), or determined by an other means available to him, e.g. recommendations by another source.

Field No.	Symbolic Code	Description of Contents
1 F	C1	See above formula
2 F	C2	See above formula
3 F	C3	See above formula

I: Acceleration Constants (LC0P ≠ 0)

If LC0P ≠ 0, the user must input constants (Refer to card H above) to be used in computing hard-rock ground acceleration from the formula

$$\log A_r = CA1 + CA2 \times \log V_r$$

Field No.	Symbolic Code	Description of Contents
1 F	CA1	See above formula
2 F	CA2	See above formula

J: Displacement Constants (LC0P ≠ 0)

If LC0P ≠ 0, the user must input constants (Refer to card H above) for computing hard-rock ground displacement from the formula

$$\log D_r = CD1 + CD2 \times \log V_r$$

Field No.	Symbolic Code	Description of Contents
1 F	CD1	See above formula
2 F	CD2	See above formula

2.1.1.2 Input to Subroutine SØILØD (See Section 3.4 of the main text.)

Card No.	No. of Cards	Input Variables
A	1	IPRØC, SIG

A: Soil Model Option and Standard Deviation Specification

Field No.	Symbolic Code	Description of Contents
1 I	IPRØC	A code for which soil model is to be specified.*
2 F	SIG	The number of standard deviations to be applied to the calculated amplification spectrum. SIG=0.0 is for mean analysis; SIG=1.0 is for 1 Sigma analysis, etc.

* IPRØC = 1 → Complex Model
= 2 → Semi-Complex Model
= 3 → Simple Method (a, b or c)
= 4 → Simple Method (d)
= 5 → Ground Particle Velocity Spectra Input directly

2.1.1.2.1 Complex Model: IPRØC = 1

Card	No. of Cards	Input Variables
A	1	ITYPE, N
B	N	THICK(I), DENSI(I), VELØC(I), PHI(I)

A: Option Card

Field No.	Symbolic Code	Description of Contents
1 I	ITYP[illegible]	= 1 Complex Model ≠ 1 Semi-Complex Model
2 I	N	Number of soil layers

B: Complex Model Data

Read data in ascending order , i.e. from base-rock up.

Field No.	Symbolic Code	Description of Contents
1 F	THICK(I)	Layer Thickness (ft)
2 F	DENSI(I)	Layer Wet Density (pcf)
3 F	VELØC(I)	Layer SH-Wave Velocity (ft/sec)
4 F	PHI(I)	Layer damping (fraction of critical)

2.1.1.2.2 Semi-Complex Model : IPRØC=2

Card	No. of Cards	Input Variables
A	1	ITYPE, N
B	1	DAMP
C	N	T(I), DE(I), W(I)

A: Option Card

Field No.	Symbolic Code	Description of Contents
1 I	ITYPE	= 1 Complex Model ≠ 1 Semi-Complex Model
2 I	N	Number of Soil Layers

B: Top Layer Damping Card

Field No.	Symbolic Code	Description of Contents
1 F	DAMP	Damping of Top Layer (fraction of critical)

C: Semi-Complex Model Data

Field No.	Symbolic Code	Description of Contents
1 F	T(I)	Layer Thickness (ft)
2 F	DE(I)	Layer Wet Density (pcf)
3 F	W(I)	Layer Moisture Content (% of Dry Weight)

2.1.1.2.3 Simple Method (a,b,c) IPR0C=3

Card	No. of Cards	Input Variables
A	1	IAPR0, N
B	N	T(I),DE(I),W(I) (IAPR0=1)
C	1	IS0IL,H20 (IAPR0=2)
D	N	V(I), DE(I) (IAPR0=3)

A: Simple Methdd Option Card

Field No.	Symbolic Code	Description of Contents
1 I	IAPR0	= 1 Simple Method (a) = 2 Simple Method (c) = 3 Simple Method (b)
2 I	N	Number of Layers if IAPR0=1, 3. N=0 if IAPR0=2. Zero must appear on the Data Card.

B: Simple Method (a) Data Card (See 2.1.1.2.2 C, above)

C: Simple Method (c) Data Card

Field No.	Symbolic Code	Description of Contents
1 I	IS0IL	Soil Code for DAF calculation. See Table 1.
2 F	H20	Depth to Water Table in Feet.

Table 1. Soil Codes for Simple Method (c)

ISØIL	Material
1	Fill or Soft Soil
2	Sandy and Clayey Ground
3	Rock Debris
4	Gypsum and Marl
5	Limestone and Sandstone
6	Granite

D: Simple Method (b) Data Card

Field No.	Symbolic Code	Description of Contents
1 F	V(I)	Layer Velocity (ft) See sample equations - Ref. 3.20
2 F	DE(I)	Layer Wet Density (pcf)

2.1.1.2.4 Simple Method (d) : IPRØC=4 (Section 3.4 of main text)

Card	No. of Cards	Input Variables
A	1	ICØDE, ISAT
B	1	H,DEN

A: Simple Method (d) Data Card

Field No.	Symbolic Code	Description of Contents
1 I	ICØDE	Geologic Period Code See Table 2.
2 I	ISAT	Saturation Code = 1 Soil is Saturated ≠ 1 Soil is Unsaturated

Table 2. Geologic Codes for Simple Method (d)

ICODE	Period	Era	Age (x 10^6 years)
1	Holocene	Cenozoic	.011
2	Quaternary		2.5 }*
3	Pleistocene		1 }
4	Pliocene		16
5	Miocene		26
6	Oligocene		35
7	Eocene		43
8	Cretaceous	Mesozoic	93
9	Juraissic		152
10	Triassic		175
11	Permian	Paleozoic	192
12	Pennsylvanian		220
13	Mississippian		245
14	Devonian		284
15	Silurian		355
16	Ordovician		390
17	Canadian		415
18	Ozarkian		440
19	Upper-Middle Cambrian		490
20	Lower Cambrian		515

*Note: In establishing the ICODE shown, the chronological sequence was not followed for these two periods.

B: Simple Method (d) Data Card

Field No.	Symbolic Code	Description of Contents
1 F	H	Depth of Soil Model,usually a minimum of 1/2 maximum plan dimension (ft)
2 F	DEN	Soil Wet Density (pcf)

If user desires, he may use the internally set value of DEN = 135 pcf by setting $DEN \leq 0.0$.

2.1.1.3 User Input of Specified Site Particle Velocity Spectrum

If the user desires, he may input his own site particle velocity spectrum. This option is invoked by specifying IPROC = 5 (See Section 2.1.1.2). Following Card A of input to subroutine SOILOD, three additional cards are required. On the first, the number of data points, NDATA, to be input is specified. On the second, values of the input period, TIN (I) are specified. On the third, corresponding values of input velocity, YIN(I), are specified. No other input data are required.

Any number of data points may be input. Subrountine SOILOD uses linear interpolation to compute the vectors T(I) and Y(I) corresponding to period increments of 0.1 sec. ranging from 0.1 sec. to 10 sec. One word of caution: although the user may specify as few as two input spectrum data points, the program will compute 100 spectrum points by linear not logarithmic interpolation. Thus if the user has picked points off a log-log plot, intermediate points may deviate significantly from straight lines on the log-log plot. To adequately define the entire spectrum from 0.1 sec. to 10 sec. periods, at least 8 to 10 points should be input.

2.1.2 Wind: Input to Subroutine WNDLØD

Card	No. of Cards	Input Variables
A	1	ISITE, ITEST, ITY, ISHAPE
B	1	SIG (ITEST = 1)
C	1	NPTS (ITEST = 1)
D	1	VEL(I), I = 1, NPTS (ITEST = 1)
E	1	RETRN(I), I = 1, NPTS (ITEST = 1)
F	1	PERIOD (ITY = 1, ITEST = 1)
G	1	BLIFE, PROB (ITY = 2, ITEST = 1)
H	1	VF (ITEST = 2)

A: Wind Load Control Card

Field No.	Symbolic Code	Description of Contents
1 I	ISITE	Code that describes terrain surrounding the structure-Table 3
2 I	ITEST	= 1 Statistical Analysis = 2 Deterministic Analysis
3 I	ITY	ITY specifies statistical approach to be used. = 1 Return Period Analysis = 2 Life and Probability of non-occurrence analysis = 0 Deterministic Analysis
4 I	ISHAPE	= 1 External Pressure Coefficients stored in program will be used = 2 User will specify external pressure coefficients

B: Specification of Standard Deviation

Field No.	Symbolic Code	Description of Contents
1 F	SIG	Number of standard deviations for specification of wind velocities SIG = 0.0 is for mean analysis

Table 3. Power Law Exponents for Various Terrains and Input Codes

ISITE	Description of the Terrain	Power Law Exponent (1/α)
1	For centers of large cities	1/3
2	For wooden countryside, parkland, towns, outskirts of large cities, rough coastal belts	1/4.5
3	For open country, flat coastal belts, small islands situated in large bodies of water, prairie grassland, tundra, etc.	1/7

C: Statistical Analysis Card

Field No.	Symbolic Code	Description of Contents
1 I	NPTS	Number of velocities and return periods from Thom's maps (Fig. 6 to 10 and Table 4. for use in regression analysis.

D: Wind Velocities for Statistical Analysis

Field No.	Symbolic Code	Description of Contents
1 F	VEL(I), I=1, NPTS	Velocities (fastest-mile, mph) from Thom's maps for regression analysis

E: Wind Velocity Return Periods for Statistical Analysis (for use if ITEST = 1

Field No.	Symbolic Code	Description of Contents
1 F	RETRN(I), I=1, NPTS	Return periods in years corresponding to velocities in D above

F: Return Period

Field No.	Symbolic Code	Description of Contents
1 F	PERIOD	Return period in years to find design velocity use the results of regression analysis from C, D, E above

G: Life Probability of Non-occurrence Analysis

Field No.	Symbolic Code	Description of Contents
1 F	BLIFE	Life of the structure in years.
2 F	PROB	Probability that the calculated wind velocity from regression analysis will not be exceeded during BLIFE.

H: Deterministic Wind Velocity

Field No.	Symbolic Code	Description of Contents
1 F	VF	User value of wind velocity - fastest mile data in mph.

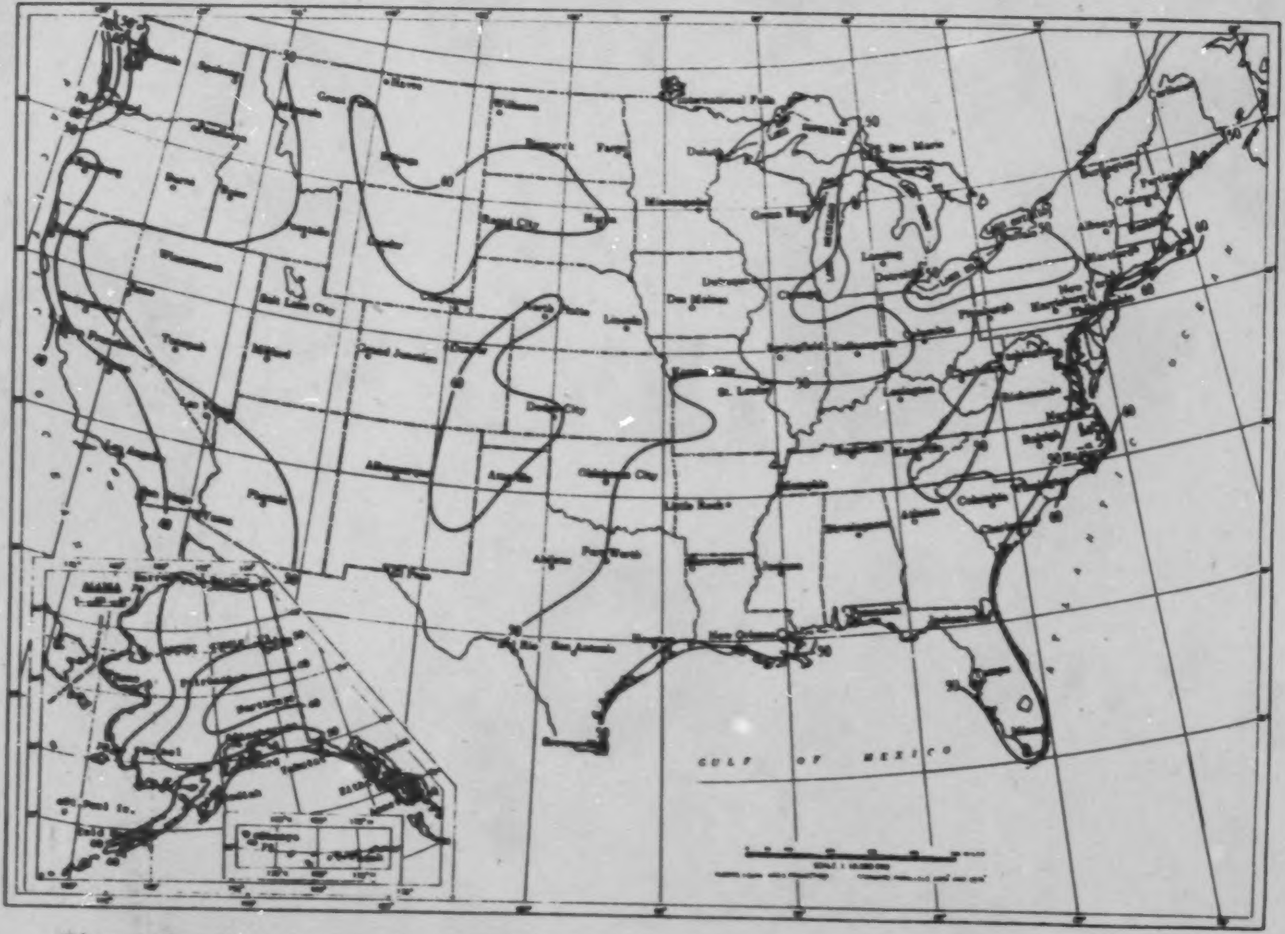

International Falls
Sault Ste Marie
Green Bay
Des Moines
Kansas City
St. Louis
Salt Lake City
Grand Junction
Dodge City
Oklahoma City
Little Rock
Fort Worth
San Antonio
New Orleans
GULF OF MEXICO
50
60

Figure 6. Mean Return Wind Velocity in Miles Per Hour - 2 Year Return Period

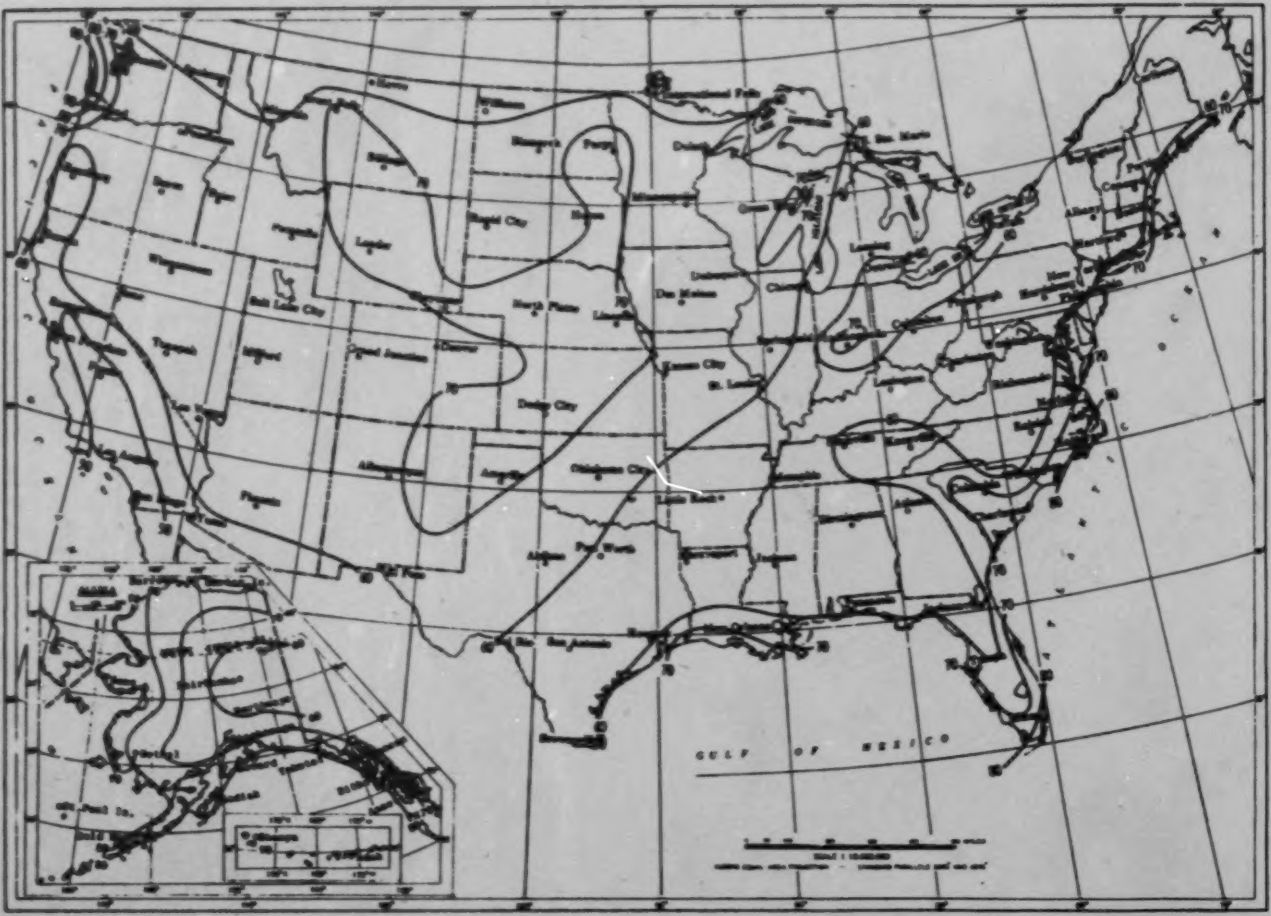

GULF OF MEXICO
Salt Lake City
Kansas City
St. Louis
Oklahoma City
Little Rock
Des Moines
North Platte
Dodge City
Rapid City
Denver
Fort Worth
San Antonio
El Paso
Albuquerque
Lander
Sault Ste. Marie
ALASKA
St. Paul Is.
70
60
80
90

Figure 7. Mean Return Wind Velocity in Miles Per Hour - 10 Year Period

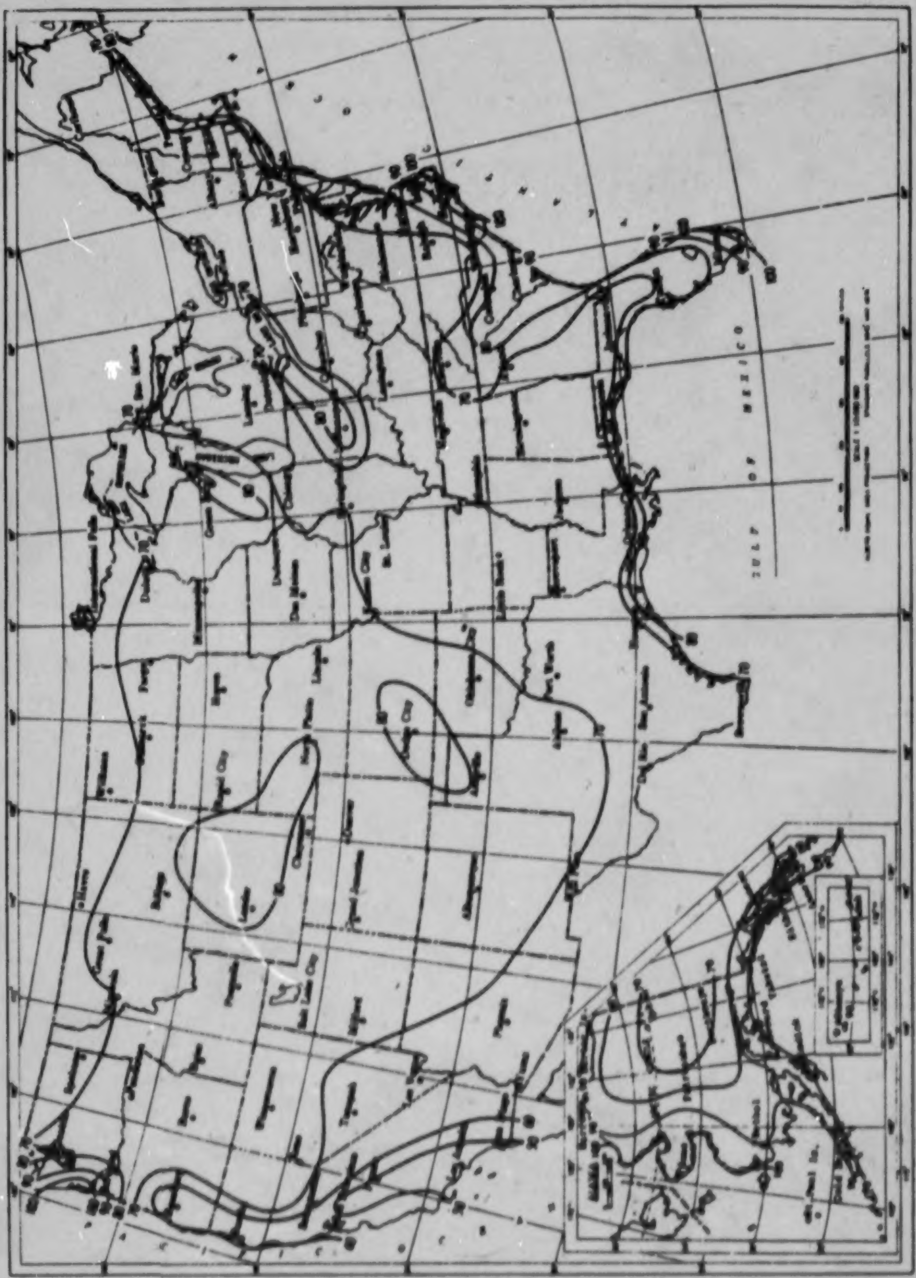

GULF OF MEXICO

Figure 8. Mean Return Wind Velocity in Miles Per Hour - 25 Year Return Period

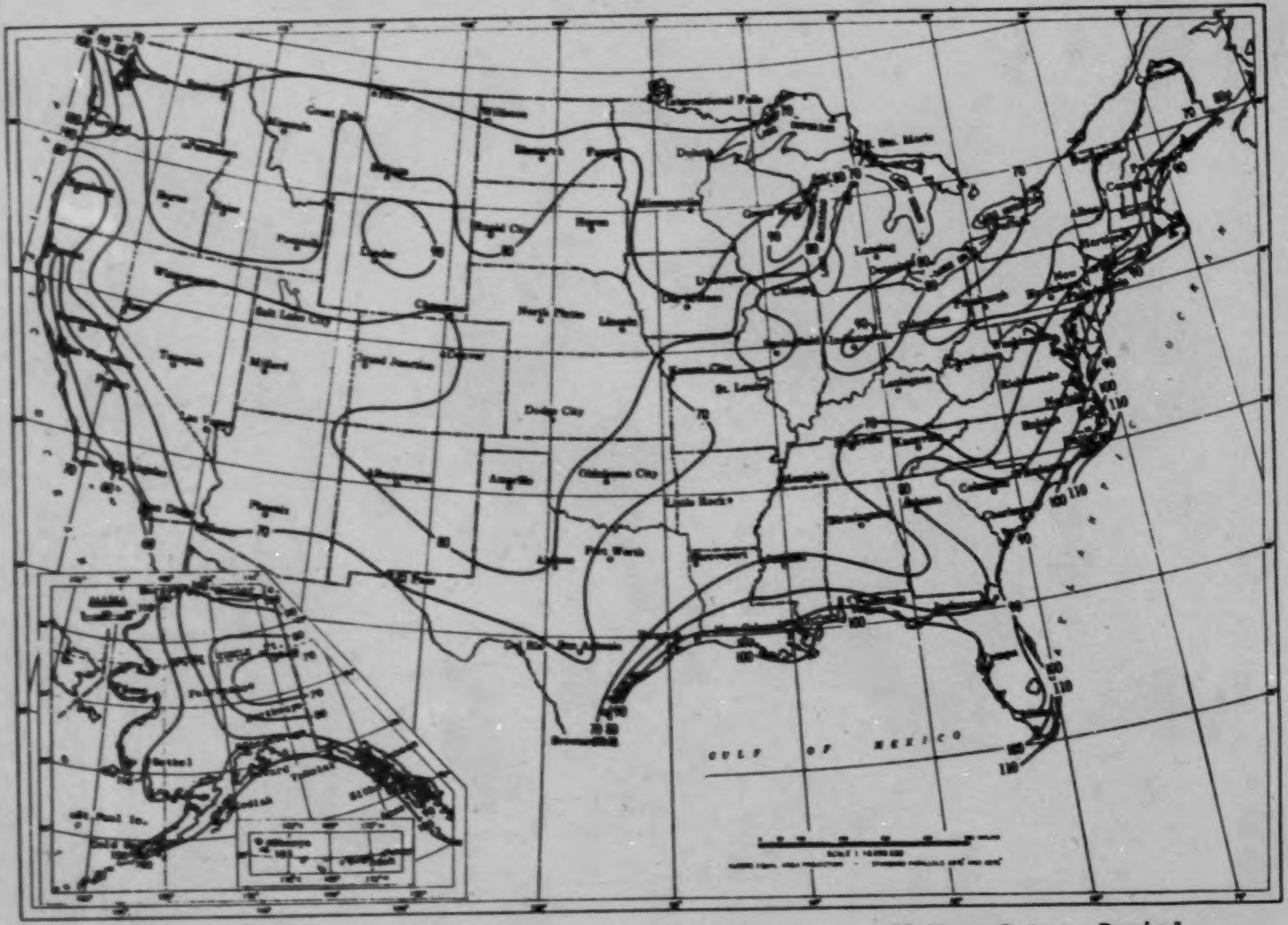

North Platte
Lincoln
Kansas City
St. Louis
Dodge City
Amarillo
Oklahoma City
Little Rock
Memphis
Fort Worth
70
80
90
100
110
GULF OF MEXICO

Figure 9. Mean Return Wind Velocity in Miles Per Hour - 50 Year Return Period

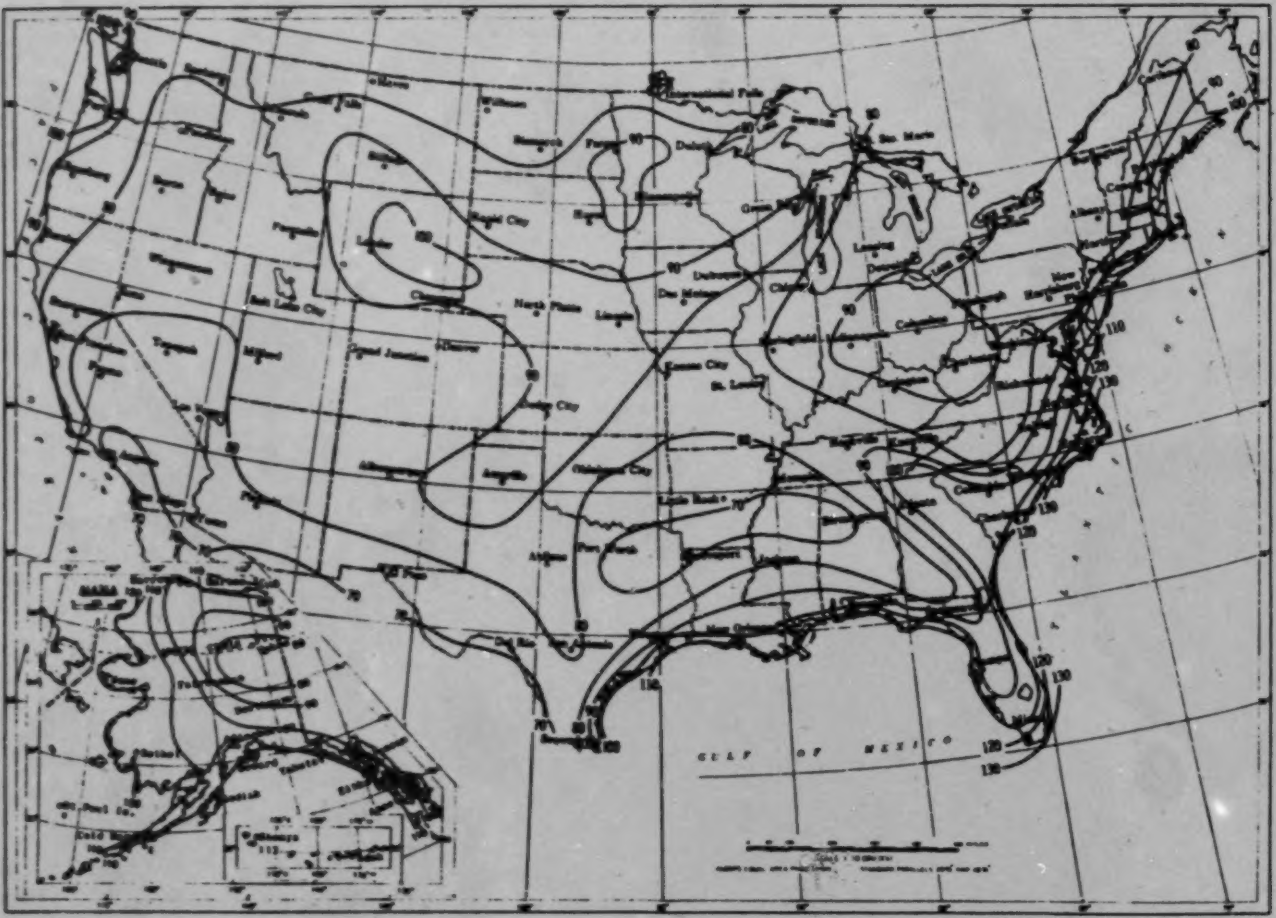

GULF OF MEXICO
Kansas City
St. Louis
Columbus
Little Rock
Oklahoma City
New Orleans
Salt Lake City
North Platte
Rapid City
Grand Junction
Denver
ALASKA
70
80
90
110
120
130

Figure 10. Mean Return Wind Velocity in Miles Per Hour - 100 Year Return Period

Table 4. Hawaii Fastest Mile Data (mph) at Sea Level*

Exposure	Return Period in Years				
	2	10	25	50	100
Leeward (Westerly)	38	51	60	67	75
Windward (Easterly)	42	59	70	80	91

* The following footnote applies only to Hawaii.

Since the data of Table 4 is taken at sea level stations, it must be converted to an equivalent fastest mile wind velocity at 30 feet above the ground for a site at an elevation Z feet above sea level. The user must do the following conversion before entering the data into the wind program:

$$V_{Z30} = V_{30} \left(\frac{Z + 30}{30} \right)^{1/7}$$

where

V_{30} = a velocity from Table 4.

Z = elevation of site above sea level in feet.

V_{Z30} = new fastest mile wind velocity at 30 feet above ground for the site.

2.1.3 Tornado: Input to Subroutine TRNLØD (See Section 3.4 of the main text.)

Card	No. of Cards	Input Variables
A	1	BL, F1, ITØR
B	1	VT (ITØR ≠ 0)

A: Site Card

Field No.	Symbolic Code	Description of Contents
1 F	BL	Building Life
2 F	F1	Number of tornados per year from Figure 11.
3 I	ITØR	= 0 Omit Wind Loads ≠ 0 Compute static response and damage due to pressure loads

B: Velocity Card

Field No.	Symbolic Code	Description of Contents
1 F	VT	Tornado Wind Velocity

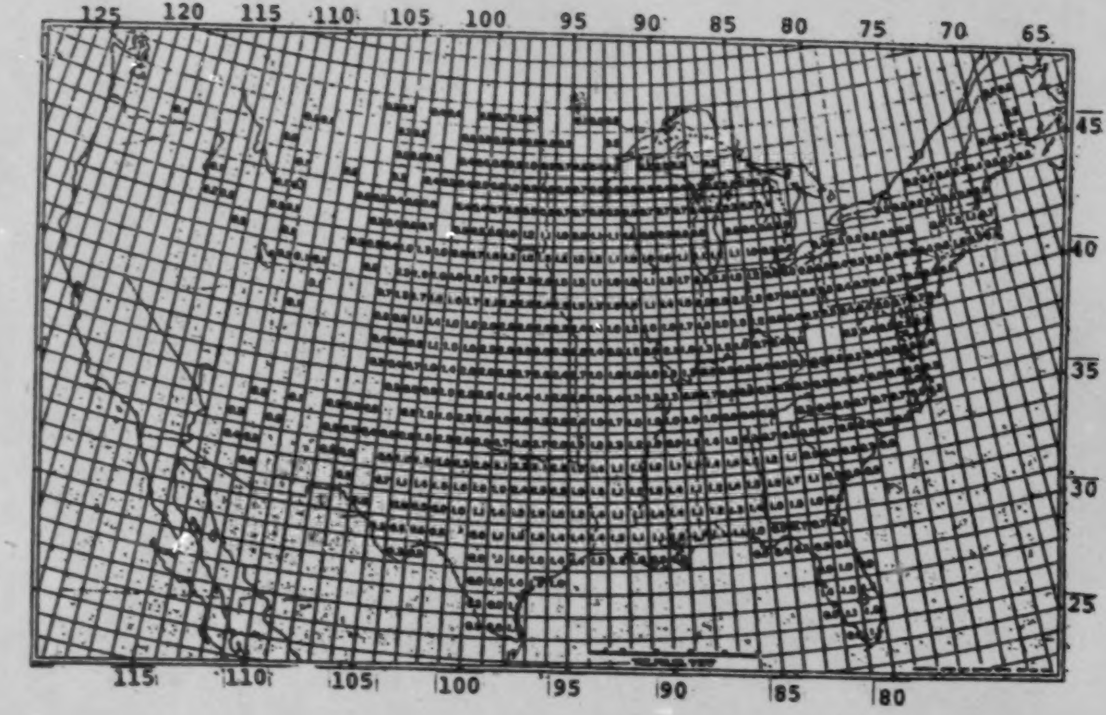

125
120
115
110
105
100
95
90
85
80
75
70
65
45
40
35
30
25
115
110
105
100
95
90
85
80

Figure 11. Mean Annual Frequency of Tornados 1953-1962, Parameter F1.

2.2 Structural Model: Input to Subroutine STRUCT

See Section 3.4 of the main text.

Card	No. of Cards	Input Variables
A	1	NS, TWB, TLB, PHR, NØPRT

A: Structure Configuration Card

Field No.	Symbolic Code	Description of Contents
1 I	NS	Number of stories
2 F	TWB	Total width of building
3 F	TLB	Total length of building
4 F	PHR	Parapet height
5 I	NØPRT	= 1 Suppress portions of printed output

2.2.1 Level 1 - Detailed Frame Model: Input to Subroutine STIFF1

Card	No. of Cards		Input Variables
A	1		NFRMS
B	NFRMS	1	NØPT
			See Sub-Chart for each NØPT

A: Number of Frames

Any number frames may be used to model a building. Since the model is two-dimensional, stiffness matrices for the various frames are superposed (summed). Each frame is assumed to lie in a vertical plane parallel to the direction of motion. Thus, for example, if the outside frames contain concrete shearwalls while the inner frames are constructed primarily of steel beams and columns, each may be modeled separately and their contributions to the overall stiffness of the structure will be additive, analogous to springs acting in parallel.

The framing options presented herein offer the user considerable latitude in types of building framing options. However, it should be noted that the user may, by placing "near zero" virtual members (properties down to 10^{-4} magnitude levels may be used without numerical ill-conditioning) extend the range of framing types. K bracing and other bracing systems may be handled in this manner. Once experience is gained in this area the program usage is greatly inhanced.

Field No.	Symbolic Code	Description of Contents
1 I	NFRMS	Number of frames to be used in detailed model

B: Frame Option Card

Individual frames for a particular building may be modeled using either NØPT = 1 or 2 in any combination. The only restriction is that story heights for all frames be the same.

Field No.	Symbolic Code	Description of Contents
1 I	NØPT	= 1 Steel frame (may have non-rigid joints) = 2 General frame (used for concrete structures)

Sub-Chart for NØPT = 1: Steel Frame Model

Card	No. of Cards		Input Variables
C	1		E, NB, NBT, NCT, NBB, NBRT, NRFJ, NDLC
D	NBT		J, AB(J), IB(J), WB(J)
E	NCT		J, AC(J), IC(J), WC(J)
F	NBRT		J, ABR(J) ABR = Area of brace
G	NB*		NUM, BW
H	NS*		NUM, SH
I	NS	NB*	NUM, BT, (IFR,A,B,SCJ,SCK)$^+$
J		NC*	NUM, CT, (IFR,A,B,SCJ,SCK)$^+$
K		NBB	BN, BT1, BT2

+ Omit if NRFJ=1

* May be less (refer to detailed explanation)

Sub-Chart for NØPT = 2: General Frame Model

Card	No. of Cards		Input Variables
C	1		NB, NBT, NCT, E, G, EB, GB, WTB, WTC, NDLC
D	NBT		J, B1, D1, ISECT/T1, T2
E	NCT		J, B1, D1, ISECT/T1, T2
G	NB*		NUM, BW, BL1, AL1
H	NS*		NUM, SH
I	NS	NB*	NUM, BT
J		NC*	NUM, CT

* May be less (refer to detailed explanation)

C: **Frame Description Card**

Only one Frame Description card is used per frame. If NØPT = 1, the card contains:

Field No.	Symbolic Code	Description of Contents
1 F	E	Young's modulus
2 I	NB	Number of bays
3 I	NBT	Number of beam sections
4 I	NCT	Number of column sections
5 I	NBB	Number of braced bays
6 I	NBRT	Number of bracing types
7 I	NRFJ	If NRFJ=1, frame joints are non-rigid.
8 I	NDLC	If NDLC=1, the dead load of the framing is not included in the building mass.

If NØPT = 2, the card contains:

Field No.	Symbolic Code	Description of Contents
1 I	NB	Number of bays
2 I	NBT	Number of beam sections
3 I	NCT	Number of column sections
4 F	E	Young's modulus for columns
5 F	G	Shear modulus for columns
6 F	EB	Young's modulus for beams
7 F	GB	Shear modulus for beams
8 F	WTB	Weight of beam (lbs/cu. ft.)
9 F	WTC	Weight of column (lbs/cu. ft.)
10 I	NDLC	If NDLC=1, the dead load of the framing is not included in the building mass.

D9 Beam Properties Card

The Beam Properties card is used to override beam properties already included in the data base or to add additional beam properties for use in this particular run (refer to Table 5). The total number of cards must equal the number entered for NBT in the Frame Description card. If N0PT=1, the card contains:

Field No.	Symbolic Code	Description of Contents
1 I	J	Beam number; if it is between 1 and 81, it overrides corresponding properties in the data base; if it is between 82 and 99, it adds additional properties to the data base.
2 F	AB	Area (in.^{2})
3 F	IB	Moment of inertia (in.^{4})
4 F	WB	Weight (lb/ft)

If N0PT = 2, the card contains:

Field No.	Symbolic Code	Description of Contents
1 I	J	Beam number
2 F	B1	Beam dimension, see Fig. 12
3 F	D1*	Beam dimension, see Fig. 12
4 I	ISECT	Beam section code, see Figure 12
1 F	T1	Beam dimension enter values on next card if ISECT >2
2 F	T2	Beam dimension

---

*If ISECT = 2, D1 is not used in computation. However, the beam properties card must still contain 4 fields. Either two adjacent commas or a dummy value must be specified.

Table 5. Beam Sections Included in Stored Data Base

Beam No.	Section	Beam No.	Section
1	W16X 26	42	94
2	31	43	100
3	36	44	110
4	40	45	120
5	45	46	130
6	50	47	145
7	58	48	160
8	64	49	W27X 84
9	71	50	94
10	78	51	102
11	88	52	114
12	96	53	145
13	W18X 35	54	160
14	40	55	177
15	45	56	W30X 99
16	50	57	108
17	55	58	116
18	60	59	124
19	64	60	132
20	70	61	172
21	77	62	190
22	85	63	210
23	96	64	W33X 118
24	105	65	130
25	114	66	141
26	W21X 44	67	152
27	49	68	200
28	55	69	220
29	62	70	240
30	68	71	W36X 135
31	73	72	150
32	82	73	160
33	96	74	170
34	112	75	182
35	127	76	194
36	142	77	230
37	W24X 55	78	245
38	61	79	260
39	68	80	280
40	76	81	300
41	84		

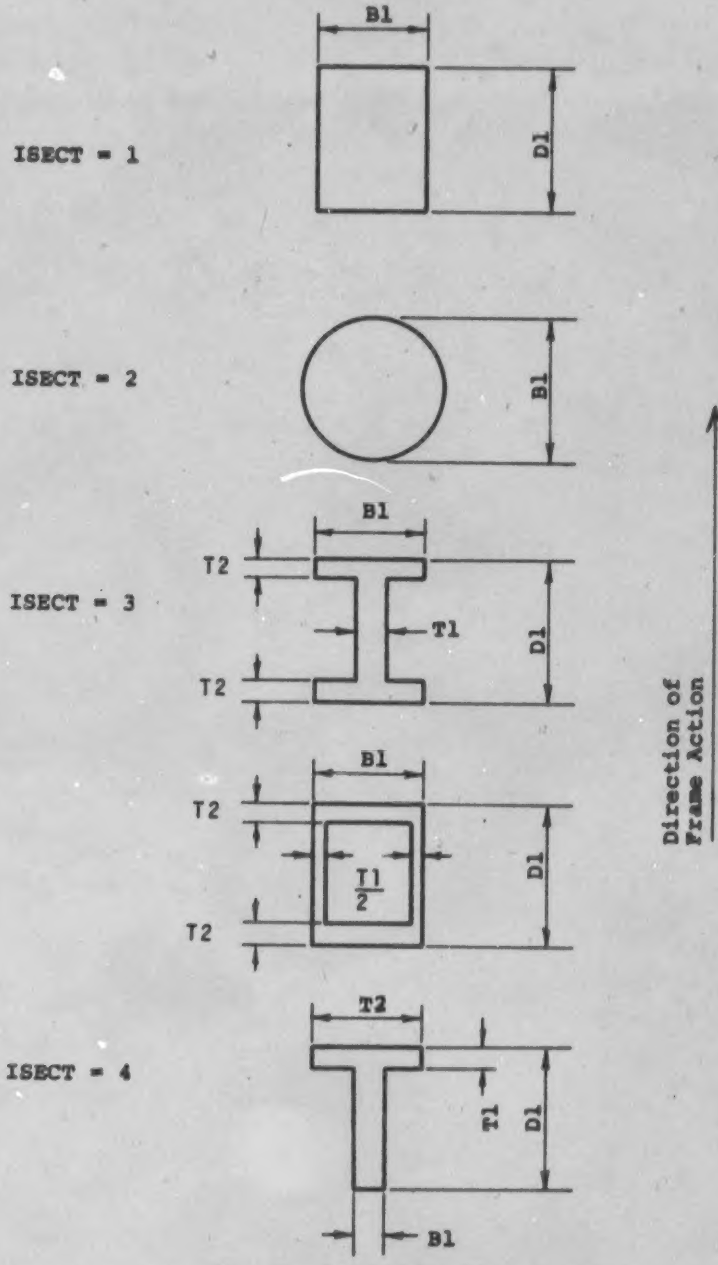

ISECT = 1
B1
D1
ISECT = 2
B1
ISECT = 3
B1
T2
T1
D1
T2
B1
T2
T1
2
D1
T2
ISECT = 4
T2
T1
D1
B1
Direction of
Frame Action

Figure 12. Beam and Column Sections

E: Column Properties Card

The Column Properties card is used to override column properties already included in the data base or to add additional column properties for use in this particular run (refer to Table 6). The total number of cards must equal the number entered for NCT in the Frame Description card. If NØPT = 1, the card contains:

Field No.	Symbolic Code	Description of Contents
1 I	J	Column number; if it is between 1 and 38 or 51 and 88, it overrides corresponding properties in the data base; if it is between 39 and 50 or 89 and 99, it adds additional properties to the data base.
2 F	AC	Area (in.^{2})
3 F	IC	Moment of inertia (in.^{4})
4 F	WC	Weight (lb/ft)

If NØPT = 2, the card contains:

Field No.	Symbolic Code	Description of Contents	
1 I	J	Column number	
2 F	B1	Column dimension, see Figure 12	
3 F	D1*	Column dimension, see Figure 12	
4 I	ISECT	Column section code, see Figure 12	
1 F	T1	Column dimension	enter values on next card if ISECT >2
2 F	T2	Column dimension	

---

*If ISECT = 2, D1 is not used in computation. However, the column properties card must still contain 4 fields. Either two adjacent commas or a dummy value must be specified.

Table 6. Column Sections Included in Stored Data Base

Column Number		Section
Strong Axis Bending	Weak Axis Bending	
1	51	W14X 61
2	52	68
3	53	74
4	54	W14X 78
5	55	84
6	56	W14X 87
7	57	95
8	58	103
9	59	111
10	60	119
11	61	127
12	62	136
13	63	W14X 142
14	64	150
15	65	158
16	66	167
17	67	176
18	68	184
19	69	193
20	70	202
21	71	211
22	72	219
23	73	228
24	74	237
25	75	W14X 246
26	76	264
27	77	287
28	78	314
29	79	342
30	80	370
31	81	398
32	82	426
33	83	W14X 455
34	84	500
35	85	550
36	86	605
37	87	665
38	88	730

F: Brace Description Card

One Brace Description card is required for each bracing type. A bracing type is associated with a diagonal bay member of a particular cross-sectional area. Any one bracing type may be used repeatedly throughout the frame and is specified by either of the variables BT1 or BT2 which are defined for Card K.

Field No.	Symbolic Code	Description of Contents
1 I	J	Integer numbers identifying bracing type
2 F	ABR (J)	Cross-sectional area of bracing member type J

G: Bay Description Card

One Bay Description card is required for each set of consecutive bays with identical widths. The total number of cards is always less than or equal to the number of bays NB in the Frame Description card. If NØPT = 1, enter only items in fields 1 and 2. If NØPT = 2, enter all four items.

Field No.	Symbolic Code	Description of Contents
1 I	NUM	Number of consecutive bays of identical width
2 F	BW	Bay width
3 F	BL1	Distance to face of column left end of span (see Figure 13)
4 F	AL1	Distance to face of column right end of span (see Figure 13)

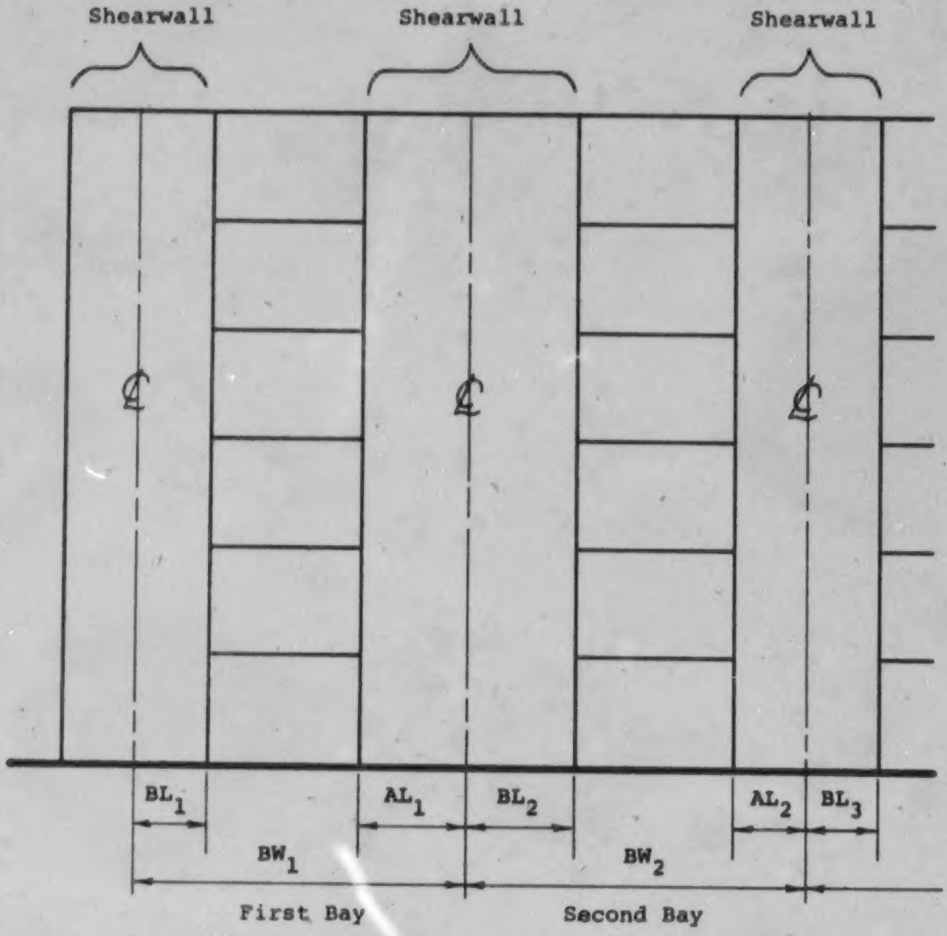

Shearwall
Shearwall
Shearwall
℄
℄
℄
BL1
AL1
BL2
AL2
BL3
BW1
BW2
First Bay
Second Bay

Figure 13. Bay Dimensions for NØPT = 2

H: Story Description Card

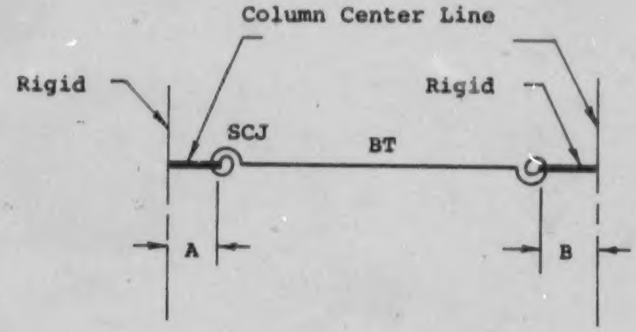
One Story Description card is required for each set of consecutive stories with identical height. The total number of cards is always less than or equal to the number of stories indicated in field 3 (NS) of the Control card.

Field No.	Symbolic Code	Description of Contents
1 I	NUM	Number of consecutive stories of identical height
2 F	SH	Story height

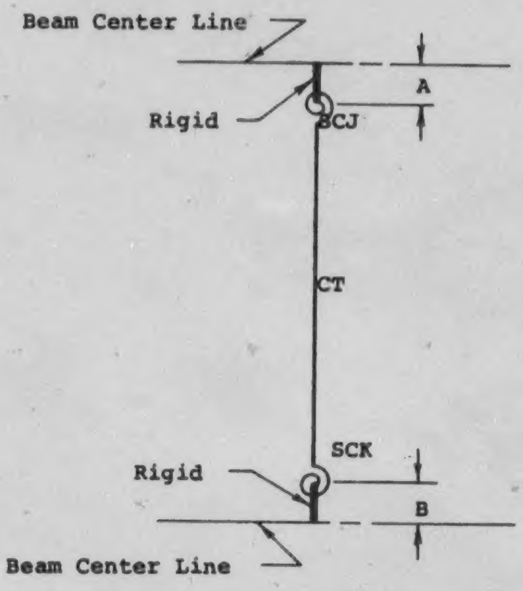
I: Beam Card

One Beam card is required for each set of consecutively identical members for each story. The total number of cards per story is always less than or equal to the number of bays. If NØPT = 1 and NRFJ = 1, omit fields 3 through 7. If NØPT = 2, omit fields 3 through 7.

Field No.	Symbolic Code	Description of Contents
1 I	NUM	Number of consecutively identical beams, starting from the left.
2 I	BT	Type of beam from data base (Table 5) or input (Beam Properties card).
3 I	IFR	IFR≠ 1 joints are assumed rigid and the values for SCJ and SCK that are read in are ignored.
4 F	A	Dimension of rigid joint at left end (see Fig. 14).
5 F	B	Dimension of rigid joint at right end (see Fig. 14).
6 F	SCJ	Spring constant left end (see Figure 14).
7 F	SCK	Spring constant right end (see Figure 14).


Column Center Line
Rigid
Rigid
SCJ
BT
A
B

BEAM


Beam Center Line
A
Rigid
SCJ
CT
SCK
Rigid
B
Beam Center Line

COLUMN

Figure 14. Beam and Column for NØPT = 1

J: Column Card

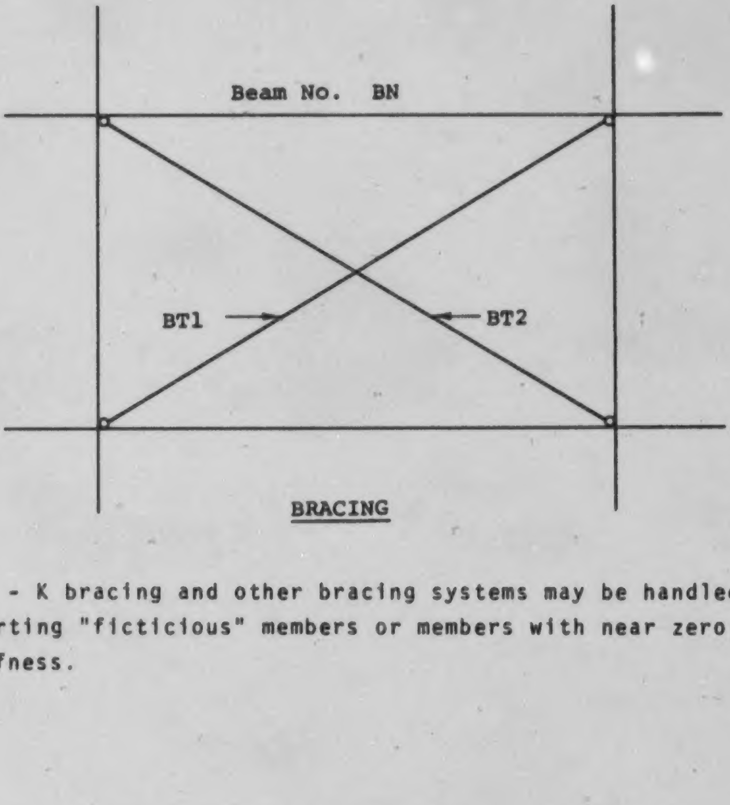
One Column card is required for each set of consecutively identical columns. The total number of Column cards per story is always less than or equal to the number of bays plus 1 (Figure 4). If NØPT = 1 and NRFJ = 1, omit fields 3 through 7. If NØPT = 2, omit fields 3 through 7.

Field No.	Symbolic Code	Description of Contents
1 I	NUM	Number of consecutively identical columns, starting from the left.
2 I	CT	Type of column from data base (Table 6) or input (Column Properties card).
3 I	IFR	IFR=1, joints are assumed rigid and the values for SCJ and SCK that are read in are ignored.
4 F	A	Dimension of rigid joint at top end (see Figure 14).
5 F	B	Dimension of rigid joint at bottom end(see Figure 14).
6 F	SCJ	Spring constant top end (see Figure 14).
7 F	SCK	Spring constant bottom end (see Figure 14).

K: Brace Card

The number of Brace cards is always equal to NBB. Refer to Figure 15 for the orientation of the pair of braces.

Field No.	Symbolic Code	Description of Contents
1 I	BN	Beam number (refer to Figure 11).
2 I	BT1	Brace type for first brace.
3 I	BT2	Brace type for second brace.



BRACING

Note - K bracing and other bracing systems may be handled by inserting "ficticious" members or members with near zero stiffness.

Figure 15. Braces for NØPT = 1

2.2.2 Level 2 - Story Stiffness Model: Input to Subroutine STIFF2

Card	No. of Cards	Input Variable
A	1	SK(I), I=1, NS
B	1	LC(I), I=1, NS

A: Story Stiffness Card

Story stiffness coefficients are read form this card, top to bottom. These stiffnesses correspond to the springs shown in Figure 2. They need not represent translational stiffnesses of column type structures where both ends of the column are constrained against rotation. Although this is one interpretation, resulting modal frequencies may be too high so that somewhat smaller stiffness coefficients should be used.

Field No.	Symbolic Code	Description of Contents
1 to NS F	SK(I)	Stiffness coefficient for the Ith story

B: Story Height Card

Field No.	Symbolic Code	Description of Contents
1 to NS F	LC(I)	Height of Ith story

2.2.3 Level 3 - Empirical Model: Input to Subroutine STIFF3

Card	No. of Cards	Input Variables
A	1	TI
B	1	LC(I), I=1, NS

A: Fundamental Period

Field No.	Symbolic Code	Description of Contents
1 F	TI	Fundamental Period

B: Story Heights

Field No.	Symbolic Code	Description of Contents
1 to NS F	LC (I)	Height of Ith Story

2.2.4 Floor Weight - Input to Subroutine FLMASS

Card	No. of Cards	Input Variables
A	1	FWT(I), I = 1, NS

A: Floor Weight

Field No.	Symbolic Code	Description of Contents
1 to NS F	FWT (I)	Weight of Ith floor in KIPS

2.3 Response (See Section 3.4 of the main text)

2.3.1 Input to Subroutine DYNAMC

Card	No. of Cards	Input Variables
A	1	NDAMP, ITERMX, LD, MCØP
B	1	DRFTY(I), I=1, NS

A: Option Card

Field No.	Symbolic Code	Description of Contents
1 I	NDAMP	= 1 Damping for steel and reinforced concrete frame structures = 2 Damping for bolted steel frame or timber structures
2 I	ITERMX	Maximum number of iterations allowed to converge on damping and ductility.
3 I	LD	= 0 Do not modify damped response spectrum to account for ductility. ≠ 0 Modify response spectrum for ductility.
4 I	MCØP	Modal Combination Option = 1 First Mode Only = 2 RSS = 3 Sum absolute values

B: Story Drift to Yield

This quantity, Δ_y, is used to compute ductility = Δ/Δ_y and represents the drift of each story at which yielding begins to occur somewhere within the primary structure of that story. The user should input appropriate values according to whether yielding occurs first to frame or structural walls.

Field No.	Symbolic Code	Description of Contents
1 to N F	DRFTY (I)	Interstory drift to yield for each story

2.3.2 Input to Subroutine STATIC, NHAZ(2) ≠ 0

See Section 3.4 of the main text.

Card	No. of Cards	Input Variables
A	1	BS
B	1	ITYPE*, ANGLE (ISHAPE = 1)
C	1	CA, CB, ANGLE (ISHAPE = 2)
D	1	CC, CD (ISHAPE = 2)
E	1	RATIO, IWALL

*See Table 7 for values of ITYPE for specific building configurations.

A: Ambient Damping for Wind Analysis

Field No.	Symbolic Code	Description of Contents
1 F	BS	Building Damping Under Wind Conditions as a fraction of critical. This value should be less than the damping of the building under strong earthquake conditions.

B. Specification of External Presure Coefficients Using Stored Data

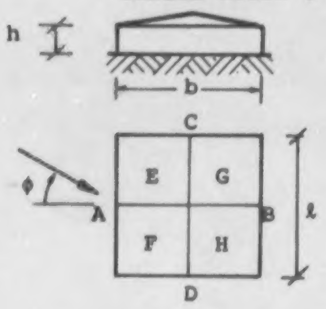
For Use if ISHAPE = 1. See Section 2.1.2, Card A.

Field No.	Symbolic Code	Description of Contents
1 I	ITYPE	Code from Table 7 for specification of building's shape
2 I	ANGLE	Code from Table 8 for specification of wind direction.

Table 7. Building Identification by Code ITYPE Using Swiss and ANSI A58.1 - 1972 Data, External Pressure Coefficients. All Data Are Swiss Unless Otherwise Noted.

ITYPE

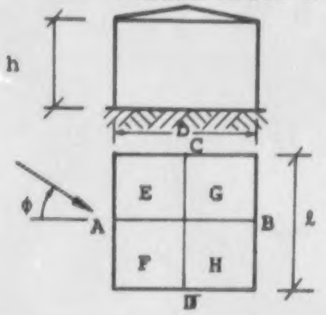
1 Gabled Roofs 0°-3°



$h:b:\ell = 1:4:4$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.4	-.4	-.8	-.8	-.3	-.3
45°	.5	-.4	.5	-.4	-.9	-.6	-.6	-.3
90°	-.4	-.4	.9	-.3	-.8	-.3	-.8	-.3

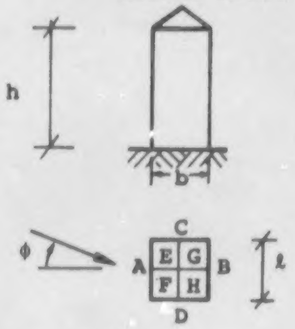
2 Gabled Roofs 0°-10°



$h:b:\ell = 1:1:1$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	-.7	-.7	-.5	-.5
45°	.5	-.5	.5	-.5	-.8	-.5	-.5	-.4
90°	-.6	-.6	.9	-.5	-.7	-.5	-.7	-.5

3 Gabled Roofs 0°-15°



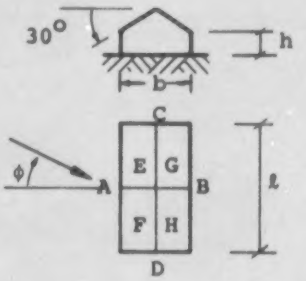
$h:b:\ell = 2.5:1:1$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.6	-.7	-.7	-.8	-.8	-.8	-.8
45°	.5	-.5	-.5	-.5	-.8	-.7	-.7	-.5
90°	-.7	-.7	.9	-.6	-.8	-.8	-.8	-.8

Table 7. Building Identification (Continued)

I TYPE

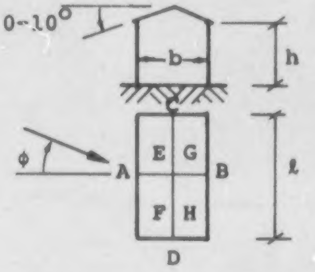
4


30°
h
b
C
φ
A
E
G
F
H
B
ℓ
D

h:b:ℓ = 1:8:16

φ	A	B	C	D	E	F	G	H
0°	.8	-.5	-.5	-.5	.2	.2	-.6	-.6
45°	.5	-.5	.4	-.3	.1	-.1	-.8	-.5
90°	-.3	-.3	.9	-.3	-.5	-.1	-.5	-.1

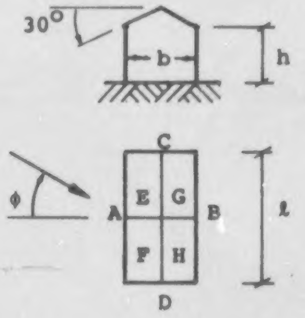
5


0-10°
b
h
C
φ
A
E
G
F
H
B
ℓ
D

h:b:ℓ = 2.5:2:5

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.7	-.7	-.6	-.6	-.5	-.5
45°	.6	-.5	.4	-.5	-.9	-.7	-.6	-.7
90°	-.5	-.5	.9	-.4	-.8	-.2	-.8	-.2

6


30°
b
h
C
φ
A
E
G
F
H
B
ℓ
D

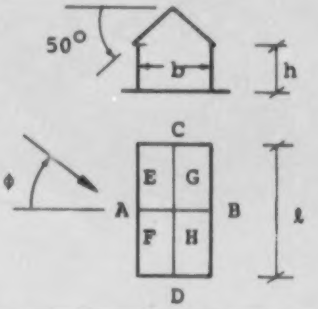
h:b:ℓ = 2.5:2:5

φ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.7	-.7	-.6	-.6	-.5	-.5
45°	.6	-.5	.4	-.4	-.4	-.5	-.6	-.7
90°	-.5	-.5	.9	-.4	-.7	-.2	-.7	-.2

Table 7. Building Identification (Continued)

I TYPE

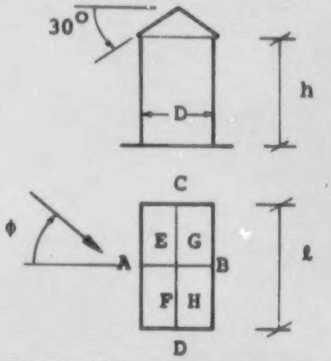
7


50°
b
h
C
ϕ
E
G
A
B
F
H
ℓ
D

$h:b:\ell = 2.5:2:2.5$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.7	-.8	.3	.3	-.6	-.6
45°	.6	-.5	.4	-.4	.3	-.1	-.5	-.6
90°	-.5	-.5	.9	-.4	-.8	-.2	-.8	-.2

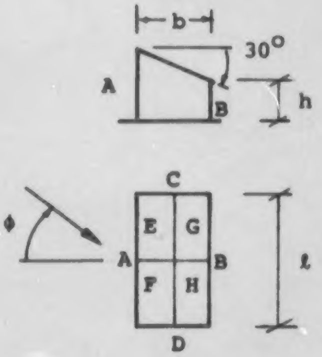
8


30°
D
h
C
ϕ
E
G
A
B
F
H
ℓ
D

$h:b:\ell = 2:1:2$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.8	-.8	-1.0	-1.0	-.5	-.5
45°	.6	-.5	.4	-.4	-.3	-.4	-.5	-.6
90°	-.6	-.6	.9	-.4	-.7	-.5	-.7	-.5

9


b
30°
A
B
h
C
ϕ
E
G
A
B
F
H
ℓ
D

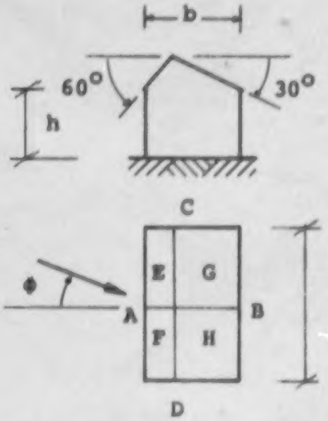
$h:b:\ell = 1:2.4:12$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	-.5	-.5	-.5	-.5
45°	.5	-.6	.4	-.4	-1.2	-.7	-1.1	-.7
90°	-.4	-.3	.9	-.2	-.3	0	-.3	0

Table 7. Building Identification (Continued)

I TYPE

10

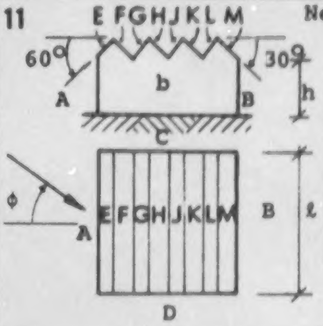


b
60°
30°
h
C
ϕ
E
G
A
B
F
H
D

h:b:ℓ = 1:1:5

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.5	-.6	-.6	.6	.6	-.5	-.5
45°	.5	-.8	.4	-.5	.2	-.1	-1.0	-.8
90°	-.4	-.4	.9	-.3	-.4	0	-.4	0

11



E F G H J K L M
60°
30°
b
A
B
h
C
ϕ
A
E F G H J K L M
B
ℓ
D

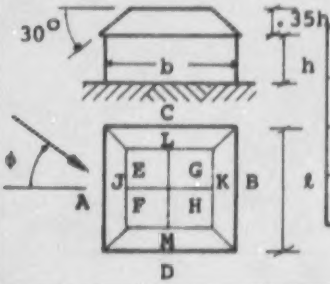
Neglect Wind Friction

h:b:ℓ = 1:4:5

ϕ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.3	-.4	-.4	.6	-.6	-.6	-.5	-.5	-.4	-.3	-.3
45°	.5	-.4	.5	-.3	.2	-.8	-.5	-.4	-.2	-.4	-.2	-.5
90°	-.4	-.4	.9	-.3	-.3	-.4	-.4	-.4	-.4	-.4	-.4	-.3

12

h:b:ℓ = 1:3:4



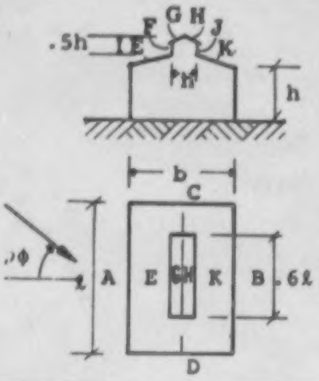
30°
.35h
b
h
C
ϕ
L
E
G
J
K
A
F
H
B
ℓ
M
D

ϕ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.5	-.6	-.6	-.8	-.8	-.4	-.4	-1.0	-.4	.5	-.5
45°	.5	-.5	.5	-.4	-.6	-.5	-.5	-.5	-.5	-.5	-.5	-.5
90°	-.5	-.5	.9	-.4	-.8	-.4	-.8	-.4	-.4	-.4	-1.0	-.4

Table 7. Building Identification (Continued)

I TYPE

13

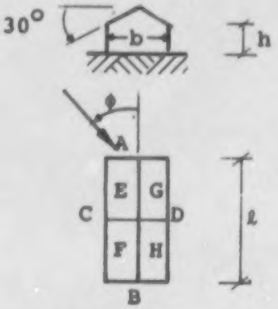


.5h
E
F
G H
J
K
H
h
b
C
ϕ
ℓ
A
E
GH
K
B
.6ℓ
D

h:b:ℓ = 1:4:8

ϕ	A	B	C	D	E	F	G	H	J	K
0°	.8	-.5	-.7	-.7	.2	.6	-1.0	-.6	-.5	-.6
45°	.4	-.5	.4	-.5	-.3	.2	-1.3	-1.4	-1.0	-.7
90°	-.4	-.4	.8	-.3	-.4	-.2	-.3	-.3	-.2	-.4

14

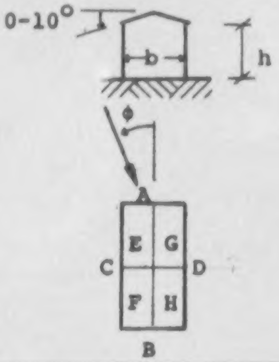


30°
b
h
ϕ
A
E
G
C
D
F
H
ℓ
B

h:b:ℓ = 1:8:16

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.3	-.3	-.5	-.1	-.5	-.1
45°	.4	-.3	.5	-.5	.1	-.1	-.8	-.5
90°	-.5	-.5	.8	-.5	.2	.2	-.6	-.6

15



0-10°
b
h
ϕ
A
E
G
C
D
F
H
B

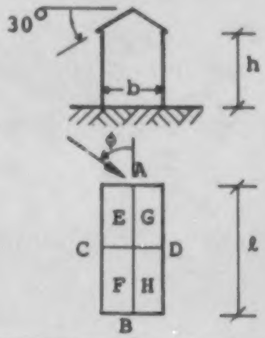
h:b:ℓ = 2.5:2:5

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.5	-.5	-.8	-.2	-.8	-.2
45°	.4	-.5	.6	-.5	-.9	-.7	-.6	-.7
90°	-.7	-.7	.9	-.5	-.6	-.6	-.5	-.5

Table 7. Building Identification (Continued)

I TYPE

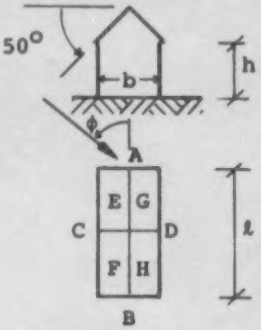
16


30°
h
b
φ
A
E
G
C
D
ℓ
F
H
B

$h:b:\ell = 2.5:2:5$

φ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.5	-.5	-.7	-.2	-.7	-.2
45°	.4	-.4	.6	-.5	-.4	-.5	-.6	-.7
90°	-.7	-.7	.9	-.5	-.6	-.6	-.5	-.5

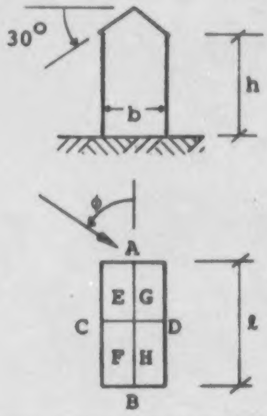
17


50°
h
b
φ
A
E
G
C
D
ℓ
F
H
B

$h:b:\ell = 2.5:2:5$

φ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.5	-.5	-.8	-.2	-.8	-.2
45°	.4	-.4	.6	-.5	.3	-.1	-.5	-.6
90°	-.8	-.8	.9	-.5	.3	.3	-.6	-.6

18


30°
h
b
φ
A
E
G
C
D
ℓ
F
H
B

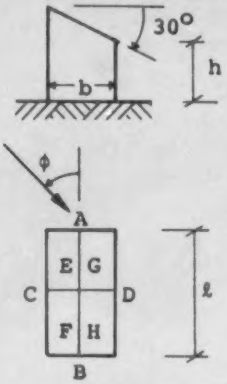
$h:b:\ell = 2:1:2$

φ	A	B	C	D	E	F	G	H
0°	.9	-.4	-.6	-.6	- .7	- .5	-.7	-.5
45°	.4	-.4	.6	-.5	- .3	- .4	-.5	-.6
90°	-.8	-.8	.9	-.5	-1.0	-1.0	-.5	-.5

Table 7. Building Identification (Continued)

I TYPE

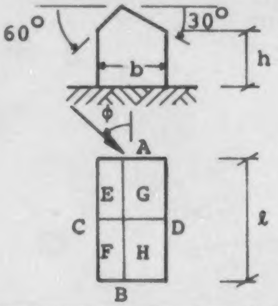
19


30°
h
b
ϕ
A
E G
C D
F H
ℓ
B

$h:b:\ell = 1:2.4:12$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.2	-.4	-.3	- .3	0	- .3	0
45°	.4	-.4	.5	-.6	-1.2	-.7	-1.1	-.7
90°	-.6	-.6	.9	-.5	- .5	-.5	- .5	-.5

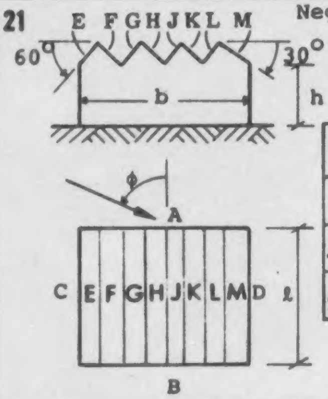
20


60°
30°
h
b
ϕ
A
E G
C D
F H
ℓ
B

$h:b:\ell = 1:1:5$

ϕ	A	B	C	D	E	F	G	H
0°	.9	-.3	-.4	-.4	-.4	0	- .4	0
45°	.4	-.5	.5	-.8	.2	-.1	-1.0	-.8
90°	-.6	-.6	.9	-.5	.6	.6	- .5	-.5

21 Neglect Wind Friction


E F G H J K L M
60°
30°
b
h
ϕ
A
C E F G H J K L M D
ℓ
B

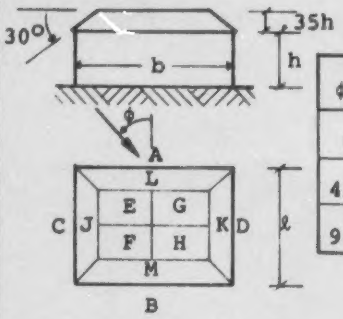
$h:b:\ell = 1:4:5$

ϕ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.3	-.4	-.4	-.3	-.4	-.4	-.4	-.4	-.4	-.4	-.3
45°	.5	-.3	.5	-.4	.2	-.8	-.5	-.4	-.2	-.4	-.2	-.5
90°	-.4	-.4	.9	-.3	.6	-.6	-.6	-.5	-.5	-.4	-.3	-.3

Table 7. Building Identification (Continued)

I TYPE

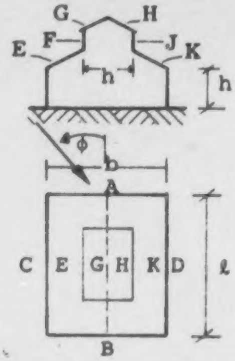
22


30°
.35h
h
b
ϕ
A
L
E
G
C
J
K
D
F
H
M
B
ℓ

h:b:ℓ = 1:3:4

ϕ	A	B	C	D	E	F	G	H	J	K	L	M
0°	.9	-.4	-.5	-.5	-.8	-.4	-.8	-.4	-.4	-.4	-1.0	-.4
45°	.5	-.4	.5	-.5	-.6	-.5	-.5	-.5	-.5	-.5	-.5	-.5
90°	-.6	-.6	.9	-.5	-.8	-.8	-.4	-.4	-1.0	-.4	-.5	-.5

23

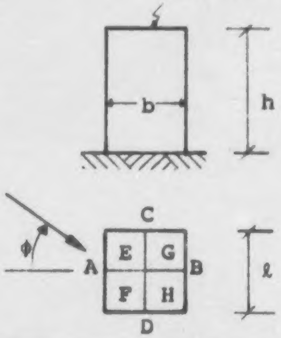

G
H
F
J
E
K
h
h
ϕ
b
A
C
E
G
H
K
D
ℓ
B

h:b:ℓ = 1:4:8

ϕ	A	B	C	D	E	F	G	H	J	K
0°	.8	-.3	-.4	-.4	-.4	-.2	-.3	-.3	-.2	-.4
45°	.4	-.5	.4	-.5	-.3	.2	-1.3	-1.4	-1.0	-.7
90°	-.7	-.7	.8	-.5	-.2	.6	-1.0	-.6	-.5	-.6

24

Essentially Flat


b
h
C
ϕ
A
E
G
F
H
B
D
ℓ

h:b:ℓ = 1:≥2.5:≥2.5

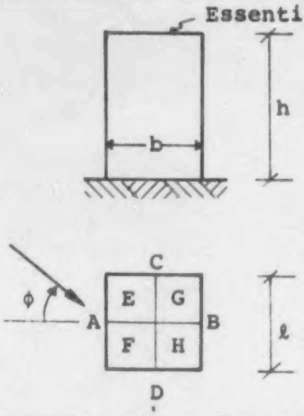
ϕ	A	B	C	D	E	F	G	H
0°	.8	-.6	-.7	-.7	-.8	-.8	-.8	-.8
90°	-.7	-.7	.8	-.6	-.8	-.8	-.8	-.8

ANSI A58.1 - 1972
(No Specifications for ϕ = 45°)

Table 7. Building Identification (Continued)

I TYPE

25


Essentially Flat
h
b
C
φ
A
E
G
F
H
B
ℓ
D

$h:b:\ell = 1:<2.5:<2.5$

ϕ	A	B	C	D	E	F	G	H
0°	.8	-.5	-.7	-.7	-.7	-.7	-.7	-.7
90°	-.7	-.7	.8	-.5	-.7	-.7	-.7	-.7

ANSI A58.1 - 1972
(No Specification for $\phi = 45°$)

Table 8. Codes for Specification of Wind Direction With Respect to Line of Frame Action

ANGLE	Direction
1	0°
2	45°
3	90°

C: User Specification of External Pressure Coefficients For Frame Action Analysis.

For use if ISHAPE = 2. See Section 2.1.2, Card A.

Field No.	Symbolic Code	Description of Contents
1 F	CA	Pressure coefficient for windward wall for frame action analysis. See Fig. 16, Wall 1
2 F	CB	Presure coefficient for leeward wall for frame action analysis. See Fig. 16, Wall 2
3 I	ANGLE	Code for wind direction with respect to line of frame action. Table 8.

D: User Specification of External Pressure Coefficients for Window Damage Estimates for Side Wall, i.e., Walls Parallel to Line of Frame Action.

Field No.	Symbolic Code	Description of Contents
1 F	CC	External Pressure Coefficient for Wall 3. See Fig. 16.
2 F	CD	External Pressure coefficient for Wall 4. See Fig. 16.

E: Window Damage Due to Wind Data.

Field No.	Symbolic Code	Description of Contents
1 F	RATIO	Ratio of open area to solid area $0. \leq$ ratio ≤ 1.
2 I	IWALL	Wall code specifying which exterior wall has the majority of openings. =1 Wall 1 See Fig. 16 =2 Wall 2 See Fig. 16 =3 Wall 3 See Fig. 16 =4 Wall 4 See Fig. 16 =5 Openings uniformly distributed.

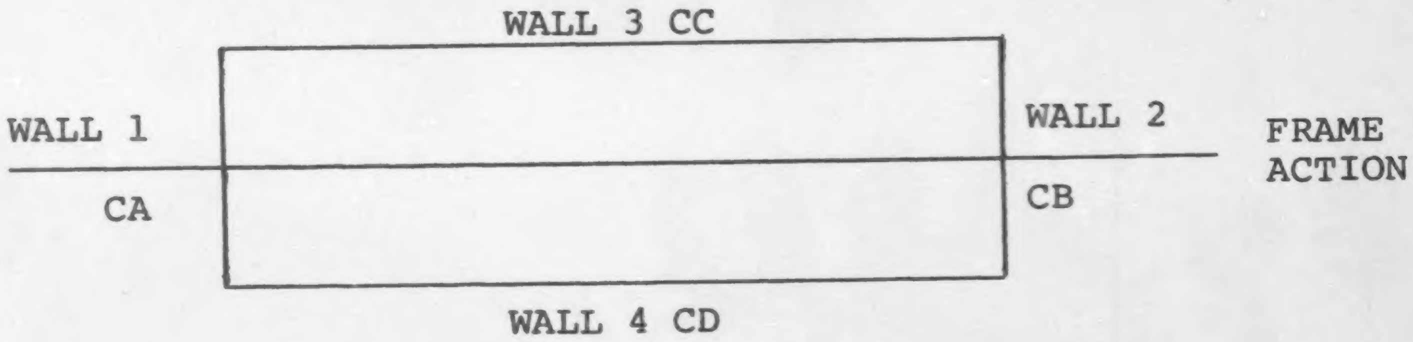

WALL 3 CC
WALL 1
CA
WALL 2
CB
FRAME ACTION
WALL 4 CD

Figure 16. Wall Numbering Convention With Respect to Line of Frame Action

2.3.3 Input to Subroutine LSR00F

Cards	No. of Cards	Input Variables
A	1	TYPEA, ALPHA, VL, CL, D0P, NP^{+}
B	1	VECTOR(I)$^{++}$, I=1, NP (TYPEA = 3)

+ Set NP=0 only if TYPEA ≠ 3

++ See Table 7 for User Input Options to VECTOR(I)

A: Long Span Roof Data Card

Field No.	Symbolic Code	Description of Contents
1 I	TYPEA	Analysis Type Code = 1 General Swiss Approach* = 2 ANSI Specifications* = 3 Detailed Analysis, User inputs roof pressure coefficients
2 F	ALPHA	Slope of Roof in Degrees
3 F	VL	Roof uplift resistance capacity in pounds. Dead weight and connection capacities to vertical uplift.
4 F	CL	Collapse Capacity of walls in pounds
5 F	D0P	Depth Of Ponding in Feet
6 I	NP	Number of data points to be read for detailed analysis. If TYPEA ≠ 3, some value must be input, say Zero (0).

---

[*] Roof pressure coefficients are generated internally for TYPEA = 1 and TYPEA = 2.

B: External Pressure Coefficients (TYPEA = 3 only)

Field No.	Symbolic Code	Description of Contents
1 to NP F	VECTOR (I)	VECTOR(I) contains roof external pressure coefficients. Suggested values are presented in Table 7. Starting with data in column E = VECTOR (1) F = VECTOR (2), etc. through H or M, depending on structure selected.

2.4 Damage

2.4.1 Input to Subroutine DAMAG for either Earthquake, Wind, Tornado, or any Combination of the Three.

Card	No. of Cards	Input Variables	
A1	1	DELTY (I,1), I=1, NS	Frame
B1	1	CVDY (I,1), I=1, NS	
A2	1	DELTY (I,2), I=1, NS	Walls
B2	1	CVDY (I,2), I=1, NS	
A3	1	DELTY (I,3), I=1, NS	Diaphragms
B3	1	CVDY (I,3), I=1, NS	
C	1	HW(I), I=1, NS	
D	1	BW(I), I=1, NS	

A1: Interstory Drift to Yield - Frame

Field No.	Symbolic Code	Description of Contents
1 to NS F	DELTY (I,1)	Interstory drift to yield See Methodology Report for empirical data.

B1: Coefficients of Variation - Frame

Field No.	Symbolic Code	Description of Contents
1 to NS F	CVDY (I,1)	Coefficient of Variation on DELTY (I,1)

A2: Interstory Drift to Yield - Walls

See B1 above for description.

B2: Coefficients of Variation - Walls

See C2 above for description.

A3: Interstory Drift to Yield - Diaphragms

See B1 above for description.

B3: Coefficients of Variation - Diaphragms

See C1 above for description.

C: Height of Windows

Field No.	Symbolic Code	Description of Contents
1 to NS F	HW (I)	Nominal window height

D: Width of Windows

Field No.	Symbolic Code	Description of Contents
1 to NS F	BW (I)	Nominal window width

2.4.2 Additional Input to Subroutine DAMAG for Earthquake Only

Card	No. of Cards	Input Variables	
A1	1	DMUF (I, 1) I=1, NS	Frame
B1	1	CVDMUF (I, 1) I=1, NS	
A2	1	DMUF (I, 2) I=1, NS	Walls
B2	1	CVDMUF (I, 2) I=1, NS	
A3	1	DMUF (I, 3) I=1, NS	Diaphragms
B3	1	CVDMUF (I, 3) I=1,NS	
C	1	Q (I) I=1, NS	
D	1	DC (I) I=1, NS	
E	1	CVDLTG(I) I=1, NS	

A1: Ductility to Failure - Frame

Field No.	Symbolic Code	Description of Contents
1 to NS F	DMUF(I,1)	Ductility to failure for structural frame. Section 3.4 of the main text for data.

B1: Coefficient of Variation on DMUF - Frame

Field No.	Symbolic Code	Description of Contents
1 to NS F	CVDMUF(I,1)	Coefficient of variation on DMUF(I,1)

A2: Ductility to Failure - Walls

See A1 above for description.

B2: Coefficient of Variation on DMUF - Walls

See B1 above for description.

A3: Ductility to Failure - Diaphragms

See A1 above for description.

B3: Coefficient of Variation on DMUF - Diaphragms

See B1 above for description.

C: Quality Factor of Nonstructural Materials

Field No.	Symbolic Code	Description
1 to NS F	Q(I)	= 1 Poor quality = 2 Minimum code quality = 3 Superior quality

D: Mullion Clearance

Field No.	Symbolic Code	Description
1 to NS F	DC(I)	Average clearance in mullions for nominal windows

E: Coefficient of Variation on Mullion Clearance

Field No.	Symbolic Code	Description
1 to NS F	CVDLTG(I)	Coefficient of variation on DC(I)

2.4.3 Additional Input to Subroutine DAMAG for Wind Only.

Card	No. Cards	Input Variables
A	1	DELTYP (I) I=1, NS
B	1	CVDYP (I) I=1, NS
C	1	THG (I) I=1, NS
D	1	SGB
E	1	CVPZR (I) I=1, NS

A: Interstory Drift to Yield

Field No.	Symbolic Code	Description
1 to NS F	DELTYP(I)	Interstory drift to yield (for nonstructural partitions) caused by wind loads.

B: Coefficients of Variation - Partition

Field No.	Symbolic Code	Description
1 to NS F	CVDYP(I)	Coefficient of variation on DELTYP(I)

C: Thickness of Glass

Field No.	Symbolic Code	Description
1 to NS F	THG(I)	Thickness of glass used in nominal windows

D: Breaking Stress of Glass

The only failure mode considered is the overstressing of glass due to direct pressure. Failure of window supports is not considered.

Field No.	Symbolic Code	Description of Contents
1 F	SGB	Breaking stress of glass (psi)

E: Coefficients of Variation on Breaking Pressure

Field No.	Symbolic Code	Description of Contents
1 to NS F	CVPZR (I)	Coefficient of variation on the breaking pressure for nominal windows

3.0 OUTPUT DESCRIPTION

Printed output is generated by the computer program. Generally, speaking, the output has been chosen to indicate which data have been read into the program, to display the primary output from loads, structural modeling, response and damage computations, and to display certain intermediate results which are helpful in interpreting the primary output. A brief discussion of output from the four major parts of the program is given in the following paragraphs, followed by a sample listing.

3.1 Loads Output

For earthquake loads the program prints out input data, the Richter Magnitude of the selected earthquake and its effective hypocentral distance from the site. Hard rock acceleration, velocity and displacement are also printed. Soils data selected as input by the user are printed next, followed by the ground velocity spectrum.

For wind loads the program prints out input data, statistical data generated by the regression analysis based on Thom's maps which includes a mean return wind velocity for specified life and probability or return period, and a standard deviation. In case the risk option is bypassed, the user input wind velocity is printed.

For tornado loads the program prints out input data on the probability of strike for the site location. If a tornado wind velocity is specified (IT0R = 1), it too is printed.

3.2 Structural Modeling Output

The program will print out all of the modeling data either input or selected from internal storage. However, the user may suppress portions of the printout by setting NOPRT = 1, in which case detailed framing data are not printed. This option is particularly useful when operating the program from a remote terminal where printed output is time consuming and costly. Gross modeling characteristics such as exterior geometry, number of stories, frames, and bays per frame are output. A stiffness matric, weight vector, and modal matrix are printed in any case.

3.3 Response Output

Input data read in this part of the program are printed. In the iterative loop of DYNAMC where damping and ductility are being computed, these quantities are output along with modal parameters and their corresponding spectral velocities. This output is helpful in establishing the sensitivity of response to these parameters. If the NOPRT option is not used (NOPRT ≠ 1), additional modal data are printed and story forces and shears are printed for each of the three modal combination options. The latter information is useful in illustrating the range of total response obtainable by selecting among the various options.

Output from STATIC consists of story drift and shears due to wind pressure forces. The same output is provided for both wind and tornado.

3.4 Damage Output

Output from DAMAG includes all of the damagiability data input by the user as well as the results of damage computations for earthquake, wind and tornado -- structural, non-structural and glass. This output is given story by story. In the case of nonstructural damage due to earthquake, the values of Modified Mercalli Intensity which form the basis of damage computations are also printed out.

Damage to long-span roofs is simply indicated by a fail or no fail type statement for each of the two modes of failure-- separation and collapse.

```
@PRT,S   NBSF.BX10      LISTING OF SAMPLE DATA INPUT          PAGE 1/2
FURPUR   T25-09/28-16:16
HASSELMAN-T*NBSF.BX10
       1   BRANDOW EXAMPLE 10
       2   1,0,0
       3   34.2,118.5
       4   1,1,0
       5   1
       6   50.,.5
       7   5.209,.350,50.
       8   1.,8.5
       9   0
      10   3,1.0
      11   2,1
      12   2,40.0
      13   6,600.,300.,0.,0
      14   1
      15   2
      16   2,1,2,3800.,1520.,2100.,840.,0.,0.,0
      17   1,12.,28.,4
      18   5.,48.
      19   1,18.,18.,1
      20   2,8.,160.,1
      21   1,480.,9.,80.
      22   1,480.,80.,9.
      23   6,144.
      24   2,1
      25   1,1
      26   1,2
      27   1,1
      28   2,1
      29   1,1
      30   1,2
      31   1,1
      32   2,1
      33   1,1
      34   1,2
      35   1,1
      36   2,1
      37   1,1
      38   1,2
      39   1,1
      40   2,1
      41   1,1
      42   1,2
      43   1,1
      44   2,1
      45   1,1
      46   1,2
      47   1,1
      48   1000.,1000.,1000.,1000.,1000.,1000.
      49   1,6,1,2
      50   .013,.013,.013,.013,.013,.013
      51   .013,.013,.013,.013,.013,.013
      52   .25,.25,.25,.25,.25,.25
      53   .013,.013,.013,.013,.013,.013
      54   .25,.25,.25,.25,.25,.25
      55   .013,.013,.013,.013,.013,.013
      56   .25,.25,.25,.25,.25,.25
      57   60.,60.,60.,60.,60.,60.
      58   60.,60.,60.,60.,60.,60.
      59   18.,18.,18.,18.,18.,18.
```

```
60    .25,.25,.25,.25,.25,.25
61    11.,11.,11.,11.,11.,11.
62    .25,.25,.25,.25,.25,.25
63    11.,11.,11.,11.,11.,11.
64    .25,.25,.25,.25,.25,.25
65    3.,3.,3.,3.,3.,3.
66    .25,.25,.25,.25,.25,.25
67    .25,.25,.25,.25,.25,.25
```

```
@XQT   GOGO                       SAMPLE OUTPUT LISTING                    PAGE 1/10
@ADD,P   NBSF.BX10
@ADD,P   NBSF.BX10
RUN IDENTIFICATION:
          BRANDOW EXAMPLE 10
INCLUDE EARTHQUAKE HAZARD:   1
INCLUDE WIND HAZARD:         0
INCLUDE TORNADO HAZARD:      0
SITE LOCATION: LATITUDE   34.20  DEGREES, LONGITUTE  118.50  DEGREES
EXERCISE RISK OPTION:        1
BUILDING MODELING OPTION:      1
EVALUATE DAMAGE TO LONG-SPAN ROOF:     0

                  E A R T H Q U A K E   L O A D   A N A L Y S I S

MEAN SEISMICITY   =    5.209+00      STANDARD DEVIATION = 3.500-01
PROBABILITY THAT EARTHQUAKE OF MAGNITUDE  7.9
OR LARGER WILL NOT OCCUR DURING A PERIOD OF    50.0 YEARS =  .500
SELECTED SEISMICITY:  MEAN PLUS  1.0  SIGMA =  5.6
HARD ROCK GROUND MOTION CHARACTERISTICS

          RICHTER MAGNITUDE              =   8.24+00
          HYPOCENTRAL DISTANCE (MILES)=   5.00+01
          HARD ROCK ACCELERATION (G)  =   8.31-02
          HARD ROCK VELOCITY (IN/SEC) =   4.27+00
          HARD ROCK DISPLACEMENT (IN) =   1.28+00

               DEPTH TO WATER TABLE =   40.00
               SOIL CODE. . . . . . =       2
               BASE SPECTRUM IN TERMS OF THE MEAN AND 1.00 STANDARD DEVIATIONS

          PERIOD (SEC)    .10    .20    .30    .40    .50    .60    .70    .80    .90    1.00
          PSV (IN/SEC)   2.06   4.13   6.19   8.25  10.31  12.38  14.44  16.50  17.28   17.28

          PERIOD (SEC)   1.10   1.20   1.30   1.40   1.50   1.60   1.70   1.80   1.90    2.00
          PSV (IN/SEC)  17.28  17.28  17.28  17.28  17.28  17.28  17.28  17.28  17.11   16.26
```

```
PERIOD (SEC)     2.10     2.20     2.30     2.40     2.50     2.60     2.70     2.80     2.90     3.00
PSV (IN/SEC)    15.48    14.78    14.14    13.55    13.01    12.51    12.04    11.61    11.21    10.84

PERIOD (SEC)     3.10     3.20     3.30     3.40     3.50     3.60     3.70     3.80     3.90     4.00
PSV (IN/SEC)    10.49    10.16     9.85     9.56     9.29     9.03     8.79     8.56     8.34     8.13

PERIOD (SEC)     4.10     4.20     4.30     4.40     4.50     4.60     4.70     4.80     4.90     5.00
PSV (IN/SEC)     7.93     7.74     7.56     7.39     7.23     7.07     6.92     6.77     6.64     6.50

PERIOD (SEC)     5.10     5.20     5.30     5.40     5.50     5.60     5.70     5.80     5.90     6.00
PSV (IN/SEC)     6.38     6.25     6.13     6.02     5.91     5.81     5.70     5.61     5.51     5.42

PERIOD (SEC)     6.10     6.20     6.30     6.40     6.50     6.60     6.70     6.80     6.90     7.00
PSV (IN/SEC)     5.33     5.24     5.16     5.08     5.00     4.93     4.85     4.78     4.71     4.64

PERIOD (SEC)     7.10     7.20     7.30     7.40     7.50     7.60     7.70     7.80     7.90     8.00
PSV (IN/SEC)     4.58     4.52     4.45     4.39     4.34     4.28     4.22     4.17     4.12     4.06

PERIOD (SEC)     8.10     8.20     8.30     8.40     8.50     8.60     8.70     8.80     8.90     9.00
PSV (IN/SEC)     4.01     3.97     3.92     3.87     3.83     3.78     3.74     3.69     3.65     3.61

PERIOD (SEC)     9.10     9.20     9.30     9.40     9.50     9.60     9.70     9.80     9.90    10.00
PSV (IN/SEC)     3.57     3.53     3.50     3.46     3.42     3.39     3.35     3.32     3.28     3.25

          STRUCTURAL ANALYSIS

NUMBER OF STORIES =     6
TOTAL BUILDING WIDTH (INCHES) =  600.0
TOTAL BUILDING LENGTH (INCHES) =  300.0
HEIGHT OF PARAPET (INCHES)     =     .0
NUMBER OF FRAMES  =     1
*** FRAME NO.  1 ***  FRAME MODELING OPTION =   2
NUMBER OF BAYS  =    2
BEAMS&     E=   2100.0  G=   840.0  W(LBS/CU.FT)=   .00
COLUMNS&   E=   3800.0  G=  1520.0  W(LBS/CU.FT)=   .00
BEAM TYPE        AB        IB          FB
        1     516.0    37827.9        1.54
```

```
COLUMN TYPE          AC          IC          FC
        1           324.0      8748.0       1.20
        2          1280.0   2730666.7       1.20
BAY WIDTHS ------
     1 BAYS AT  480.000 INCHES
     1 BAYS AT  480.000 INCHES
STORY HEIGHTS -------
     6 STORIES AT  144.000 INCHES
STORY NO.      1 -------STRUCTURE DATA
BEAM     AREA          IZ       W(DL)       BL1       AL1
   1      516.0     37827.9     .00000      9.00     80.00
   2      516.0     37827.9     .00000     80.00      9.00
COLUMN   AREA          IZ       W(DL)
   1      324.0      8748.0     .00000
   2     1280.0   2730666.7     .00000
   3      324.0      8748.0     .00000
TOTAL WEIGHT OF STORY FRAMING =            .000 KIPS
STORY NO.      2 -------STRUCTURE DATA
BEAM     AREA          IZ       W(DL)       BL1       AL1
   1      516.0     37827.9     .00000      9.00     80.00
   2      516.0     37827.9     .00000     80.00      9.00
COLUMN   AREA          IZ       W(DL)
   1      324.0      8748.0     .00000
   2     1280.0   2730666.7     .00000
   3      324.0      8748.0     .00000
TOTAL WEIGHT OF STORY FRAMING =            .000 KIPS
STORY NO.      3 -------STRUCTURE DATA
BEAM     AREA          IZ       W(DL)       BL1       AL1
   1      516.0     37827.9     .00000      9.00     80.00
   2      516.0     37827.9     .00000     80.00      9.00
COLUMN   AREA          IZ       W(DL)
   1      324.0      8748.0     .00000
   2     1280.0   2730666.7     .00000
   3      324.0      8748.0     .00000
TOTAL WEIGHT OF STORY FRAMING =            .000 KIPS
STORY NO.      4 -------STRUCTURE DATA
BEAM     AREA          IZ       W(DL)       BL1       AL1
   1      516.0     37827.9     .00000      9.00     80.00
   2      516.0     37827.9     .00000     80.00      9.00
```

THIS OUTPUT IS OMITTED
WHENEVER NOPRT = 1

```
COLUMN    AREA          IZ       W(DL)
   1       324.0     8748.0      .00000
   2      1280.0  2730666.7      .00000
   3       324.0     8748.0      .00000
TOTAL WEIGHT OF STORY FRAMING =          .000 KIPS
STORY NO.    5 -------STRUCTURE DATA
BEAM      AREA          IZ       W(DL)   BL1       AL1
   1       516.0    37827.9      .00000   9.00     80.00
   2       516.0    37827.9      .00000  80.00      9.00
COLUMN    AREA          IZ       W(DL)
   1       324.0     8748.0      .00000
   2      1280.0  2730666.7      .00000
   3       324.0     8748.0      .00000
TOTAL WEIGHT OF STORY FRAMING =          .000 KIPS
STORY NO.    6 -------STRUCTURE DATA
BEAM      AREA          IZ       W(DL)   BL1       AL1
   1       516.0    37827.9      .00000   9.00     80.00
   2       516.0    37827.9      .00000  80.00      9.00
COLUMN    AREA          IZ       W(DL)
   1       324.0     8748.0      .00000
   2      1280.0  2730666.7      .00000
   3       324.0     8748.0      .00000
TOTAL WEIGHT OF STORY FRAMING =          .000 KIPS
STIFFNESS MATRIX (KIPS/IN)
   3.07+03  -5.49+03   2.16+03   2.28+02   2.76+01   3.23+00
  -5.49+03   1.30+04  -9.48+03   1.73+03   1.77+02   2.21+01
   2.16+03  -9.48+03   1.47+04  -9.30+03   1.75+03   1.82+02
   2.28+02   1.73+03  -9.30+03   1.47+04  -9.30+03   1.77+03
   2.76+01   1.77+02   1.75+03  -9.30+03   1.47+04  -9.12+03
   3.23+00   2.21+01   1.82+02   1.77+03  -9.12+03   1.64+04
TOTAL WEIGHT VECTOR (KIPS)
   1.00+03
   1.00+03
   1.00+03
   1.00+03
   1.00+03
   1.00+03
```

THIS OUTPUT IS OMITTED
WHENEVER NOPRT = 1

```
CHARACTERISTIC VECTORS
  1.00+00  -9.45-01   6.97-01  -4.63-01   3.24-01  -1.56-01
  8.02-01  -5.28-02  -5.86-01   8.65-01  -9.08-01   5.42-01
  5.95-01   6.78-01  -8.61-01   6.51-02   3.58-01  -8.84-01
  3.90-01   1.00+00   7.49-02  -9.33-01  -3.95-03   1.00+00
  2.04-01   8.38-01   1.00+00   1.50-01  -8.25-01  -8.78-01
  6.36-02   3.71-01   8.06-01   1.00+00   1.00+00   5.81-01

                 E A R T H Q U A K E   R E S P O N S E   A N A L Y S I S

DAMPING CURVE OPTION =     1
MAXIMUM NUMBER ITERATIONS =     6
MODIFY RESPONSE FOR DUCTILITY =     1
MODAL COMBINATION OPTION =     2
EFFECTIVE INTERSTORY DRIFT TO YIELD BY STORY (IN/IN)
  1.30-02   1.30-02   1.30-02   1.30-02   1.30-02   1.30-02
CRITICAL DAMPING (PERCENT) =     6.62
MODE   FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL   MAXIMUM  AMPLITUDE    PS.SPECT.VEL. MODIFIED FOR DUCTILITY
 NO.     (CPS)   (SEC.)  RATIO   VELOCITY      BASE SHEAR   RATIO      (ACCEL)     (DISPL)
  1       .6931  1.443   .708     28.288        1355.170      .719      28.288      28.288
  2      3.0505   .328   .186     11.710         648.583     1.692      11.710      11.710
  3      7.0559   .142   .066      3.647         166.179     2.850       3.647       3.647    THIS OUTPUT IS OMITTED
  4     10.0000   .100   .027      2.063          54.839     4.183       2.063       2.063    WHENEVER NOPRT = 1
  5     10.0000   .100   .010      2.063          19.851     7.520       2.063       2.063
  6     10.0000   .100   .002      2.063           4.408    15.622       2.063       2.063
 EFFECTIVE FORCE FOR MODE NO.    1
STORY   FORCE (KIPS)   SHEAR (KIPS)   DEFLECTION    STORY DRIFT   VELOCITY ACCELERATION
  1       443.734        443.734        9.0406        1.7916       39.3700       .4437
  2       355.797        799.531        7.2490        1.8706       31.[illegible]679       .3558
  3       263.982       1063.514        5.3784        1.8562       23.4216       .2640
  4       172.878       1236.391        3.5222        1.6773       15.3385       .1729
  5        90.550       1326.941        1.8449        1.2697        8.0340       .0905
  6        28.229       1355.170        .5751          .5751        2.5046       .0282
EFFECTIVE FORCE FOR MODE NO.    2
STORY   FORCE (KIPS)   SHEAR (KIPS)   DEFLECTION    STORY DRIFT   VELOCITY ACCELERATION
```

```
  1   -324.573     -324.573       -.3414       .3223      -6.5432      -.3246
  2    -18.112     -342.685       -.0191       .2640       -.3651      -.0181
  3    232.869     -109.816        .2449       .1162       4.6945       .2329
  4    343.331      233.516        .3611       .0586       6.9213       .3433
  5    287.604      521.120        .3025       .1684       5.7979       .2876
  6    127.463      648.583        .1341       .1341       2.5696       .1275
   EFFECTIVE FORCE FOR MODE NO.  3
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION   STORY DRIFT  VELOCITY ACCELERATION
  1    102.372      102.372        .0201       .0370        .8922       .1024
  2    -86.023       16.349       -.0169       .0079       -.7497      -.0860
  3   -126.367     -110.018       -.0248       .0270      -1.1013      -.1264
  4     11.001      -99.018        .0022       .0267        .0959       .0110
  5    146.847       47.830        .0289       .0056       1.2798       .1468
  6    118.349      166.179        .0233       .0233       1.0315       .1183
   EFFECTIVE FORCE FOR MODE NO.  4
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION   STORY DRIFT  VELOCITY ACCELERATION
  1    -37.144      -37.144       -.0036       .0104       -.2284      -.0371
  2     69.391       32.247        .0068       .0063        .4267       .0694
  3      5.219       37.466        .0005       .0078        .0321       .0052
  4    -74.830      -37.364       -.0073       .0085       -.4602      -.0748
  5     12.017      -25.347        .0012       .0067        .0739       .0120
  6     80.186       54.839        .0078       .0078        .4931       .0802
   EFFECTIVE FORCE FOR MODE NO.  5
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION   STORY DRIFT  VELOCITY ACCELERATION
  1     14.449       14.449        .0014       .0054        .0889       .0144
  2    -40.509      -26.061       -.0040       .0077       -.2491      -.0405
  3     38.280       12.219        .0037       .0038        .2354       .0383
  4      -.176       12.043       -.0000       .0036       -.0011      -.0002
  5    -36.799      -24.756       -.0036       .0080       -.2263      -.0368
  6     44.607       19.851        .0044       .0044        .2743       .0446
   EFFECTIVE FORCE FOR MODE NO.  6
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION   STORY DRIFT  VELOCITY ACCELERATION
  1     -3.352       -3.352       -.0003       .0015       -.0206      -.0034
  2     11.635        8.283        .0011       .0030        .0715       .0116
  3    -18.980      -10.697       -.0019       .0040       -.1167      -.0190
  4     21.473       10.776        .0021       .0039        .1320       .0215
  5    -18.845       -8.069       -.0018       .0031       -.1159      -.0188
  6     12.477        4.408        .0012       .0012        .0767       .0125
STORY          I. S. DEFL          VELOCITY          ACCELERATION
NO.              (IN)              (IN/SEC)              (G)
 1            2.1683+00          4.7143+01          9.2562-01
 2            2.1595+00          3.3430+01          5.8147-01
 3            2.0149+00          2.9602+01          6.8570-01
 4            1.7787+00          2.2949+01          6.2369-01
```

THIS OUTPUT IS OMITTED
WHENEVER NOPRT = 1

```
5          1.4615+00          1.5528+01          5.9266-01
6          7.4590-01          6.9498+00          4.1131-01
DUCTILITY BY STORY
  1.16+00   1.15+00   1.08+00   9.50-01   7.81-01   3.98-01
EFFECTIVE DUCTILITY FOR BUILDING =     .68
CRITICAL DAMPING (PERCENT) =     5.33
MODE  FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL  MAXIMUM  AMPLITUDE    PS.SPECT.VEL. MODIFIED FOR DUCTILITY
 NO.     (CPS)   (SEC)  RATIO    VELOCITY    BASE SHEAR   RATIO     (ACCEL)     (DISPL)
 1       .6931  1.443   .708      29.314      1404.283      .719    29.314      29.314
 2      3.0504   .328   .186      12.112       670.823     1.692    12.112      12.112
 3      7.0557   .142   .066       3.770       171.789     2.850     3.770       3.770
 4      9.9997   .100   .027       2.063        54.839     4.183     2.063       2.063
 5      9.9997   .100   .010       2.063        19.851     7.520     2.063       2.063
 6      9.9997   .100   .002       2.063         4.408    15.622     2.063       2.063
 EFFECTIVE FORCE FOR MODE NO.    1
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION  STORY DRIFT  VELOCITY  ACCELERATION
  1     459.816       459.816        9.3688      1.8567      40.7980        .4598
  2     368.692       828.507        7.5121      1.93X5      32.7129        .3687
  3     273.549      1102.056        5.5736      1.9235      24.2712        .2735
  4     179.143      1281.199        3.6501      1.7382      15.8948        .1791
  5      93.831      1375.031        1.9118      1.3158       8.3254        .0938
  6      29.252      1404.283         .5960       .5960       2.5954        .0293
  EFFECTIVE FORCE FOR MODE NO.    2
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION  STORY DRIFT  VELOCITY  ACCELERATION
  1   -335.703      -335.703        -.3531       .3334      -6.7677       -.3357
  2    -18.733      -354.436        -.0197       .2731       -.3777       -.0187
  3    240.855      -113.581         .2533       .1202       4.8556        .2409
  4    355.104       241.523         .3735       .0606       7.1589        .3551
  5    297.466       538.989         .3129       .1742       5.9969        .2975
  6    131.834       670.823         .1387       .1387       2.6578        .1318
  EFFECTIVE FORCE FOR MODE NO.    3
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION  STORY DRIFT  VELOCITY  ACCELERATION
  1    105.828       105.828         .0208       .0383        .9224        .1058
  2    -88.927        16.901        -.0175       .0082       -.7751       -.0889
  3   -130.633      -113.733        -.0257       .0279      -1.1386       -.1306
  4     11.372      -102.361         .0022       .0276        .0991        .0114
  5    151.805        49.444         .0298       .0058       1.3231        .1518
  6    122.345       171.789         .0241       .0241       1.0663        .1223
  EFFECTIVE FORCE FOR MODE NO.    4
```

THIS OUTPUT IS OMITTED
WHENEVER NOPRT = 1

```
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION  STORY DRIFT  VELOCITY  ACCELERATION       PAGE 8/10
  1     -37.144       -37.144       -.0036       .0104       -.2284      -.0371
  2      69.391        32.247        .0068       .0063        .4267       .0694
  3       5.219        37.466        .0005       .0078        .0321       .0052
  4     -74.830       -37.364       -.0073       .0085       -.4602      -.0748
  5      12.017       -25.347        .0012       .0067        .0739       .0120
  6      80.186        54.839        .0078       .0078        .4831       .0802
 EFFECTIVE FORCE FOR MODE NO.   5
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION  STORY DRIFT  VELOCITY  ACCELERATION
  1      14.449        14.449        .0014       .0054        .0889       .1444
  2     -40.509       -26.061       -.0040       .0077       -.2491      -.0405
  3      38.280        12.219        .0037       .0038        .2354       .0383
  4       -.176        12.043       -.0000       .0036       -.0011      -.0002
  5     -36.799       -24.756       -.0036       .0080       -.2263      -.0368
  6      44.607        19.851        .0044       .0044        .2743       .0446
 EFFECTIVE FORCE FOR MODE NO.   6                                                   THIS OUTPUT IS OMITTED
STORY  FORCE (KIPS)  SHEAR (KIPS)  DEFLECTION  STORY DRIFT  VELOCITY  ACCELERATION  WHENEVER NOPRT = 1
  1      -3.352        -3.352       -.0003       .0015       -.0206      -.0034
  2      11.635         8.283        .0011       .0030        .0715       .0116
  3     -18.980       -10.697       -.0019       .0040       -.1167      -.0190
  4      21.473        10.776        .0021       .0039        .1321       .0215
  5     -18.845        -8.069       -.0018       .0031       -.1159      -.0188
  6      12.477         4.408        .0012       .0012        .0767       .0125
STORY          I. S. DEFL          VELOCITY          ACCELERATION
NO.              (IN)              (IN/SEC)              (G)
1              2.2456+00          4.8826+01          9.5629-01
2              2.2368+00          3.4613+01          5.9789-01
3              2.0872+00          3.0650+01          7.0752-01
4              1.8425+00          2.3746+01          6.4210-01
5              1.5135+00          1.6061+01          6.1076-01
6              7.7218-01          7.1637+00          4.2070-01
DUCTILITY BY STORY
  1.20+00 . 1.19+00  1.11+00   9.84-01   8.09-01  4.12-01
EFFECTIVE DUCTILITY FOR BUILDING =   .70
CRITICAL DAMPING (PERCENT) =    5.43
 COMBINED FORCE FOR ALL MODES (METHOD   1)
STORY  FORCE (KIPS)  SHEAR (KIPS)                                 THIS OUTPUT IS OMITTED
  1     459.816       459.816                                     WHENEVER NOPRT = 1
  2     368.692       828.507
  3     273.549      1102.056
  4     179.143      1281.199
  5      93.831      1375.031
  6      29.252      1404.283
```

```
COMBINED FORCE FOR ALL MODES (METHOD   2)

STORY    FORCE(KIPS)   SHEAR(KIPS)

   1       580.453       580.453
   2       321.834       902.287
   3       212.177      1114.465
   4       193.947      1308.411
   5       169.758      1478.169
   6        88.657      1566.827

COMBINED FORCE FOR ALL MODES (METHOD   3)

STORY    FORCE(KIPS)   SHEAR(KIPS)

   1       956.290       956.290
   2       310.144      1266.434
   3       123.318      1389.752
   4       295.513      1685.265
   5       336.372      2021.637
   6       304.356      2325.993

                 D A M A G E   A N A L Y S I S

DRIFT TO YIELD BY STORY (FRAME)
   1.30-02    1.30-02    1.30-02    1.30-02    1.30-02    1.30-02
COEFFICIENT OF VARIATION BY STORY
   2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
DRIFT TO YIELD BY STORY (WALL)
   1.30-02    1.30-02    1.30-02    1.30-02    1.30-02    1.30-02
COEFFICIENT OF VARIATION BY STORY
   2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
DRIFT TO YIELD BY STORY (DIAPHRAGM)
   1.30-02    1.30-02    1.30-02    1.30-02    1.30-02    1.30-02
COEFFICIENT OF VARIATION BY STORY
   2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
HEIGHT OF WINDOWS BY STORY (INCHES)
   6.00+01    6.00+01    6.00+01    6.00+01    6.00+01    6.00+01
WIDTH OF WINDOWS BY STORY (INCHES)
   6.00+01    6.00+01    6.00+01    6.00+01    6.00+01    6.00+01
DUCTILITY TO FAILURE BY STORY (FRAME)
```

THIS OUTPUT IS OMITTE
WHENEVER NOPRT = 1

```
    1.80+01    1.80+01    1.80+01    1.80+01    1.80+01    1.80+01
COEFFICIENT OF VARIATION BY STORY
    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
DUCTILITY TO FAILURE BY STORY (WALL)
    1.10+01    1.10+01    1.10+01    1.10+01    1.10+01    1.10+01
COEFFICIENT OF VARIATION BY STORY
    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
DUCTILITY TO FAILURE BY STORY (DIAPHRAGM)
    1.10+01    1.10+01    1.10+01    1.10+01    1.10+01    1.10+01
COEFFICIENT OF VARIATION BY STORY
    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
QUALITY FACTOR OF CONSTRUCTION BY STORY
    3.00+00    3.00+00    3.00+00    3.00+00    3.00+00    3.00+00
AVERAGE CLEARANCE IN MULLIONS (INCHES)
    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01
COEFFICIENT OF VARIATION BY STORY
    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01    2.50-01

STRUCTURAL DAMAGE DUE TO EARTHQUAKE (PERCENT)

STORY                FRAME           WALL            DIAPHRAGM
 NO.                 DAMAGE          DAMAGE          DAMAGE

  1                   21.39           78.77            78.77
  2                   21.02           78.21            78.21
  3                   15.41           67.72            67.72
  4                    8.56           47.49            47.49
  5                    3.30           22.19            22.19
  6                     .19             .94              .94

NONSTRUCTURAL DAMAGE DUE TO EARTHQUAKE (PERCENT)

STORY    MMI        MMI        MMI       MULLION    NONSTR     GLASS
 NO.     (A)        (V)       (A,V)       DRIFT     DAMAGE     DAMAGE

  1      10.2        9.8       10.2      1.56-02    10.40      39.85
  2       9.5        9.4        9.5      1.55-02     4.20      39.28
  3       9.8        9.2        9.8      1.45-02     5.81      30.11
  4       9.6        8.9        9.6      1.28-02     4.82      17.64
  5       9.5        8.5        9.5      1.05-02     4.37       6.98
  6       9.0        7.5        9.0      5.36-03     2.13        .33

END OF JOB.
```

INPUT INSTRUCTIONS FOR THE CDC 3600 COMPUTER

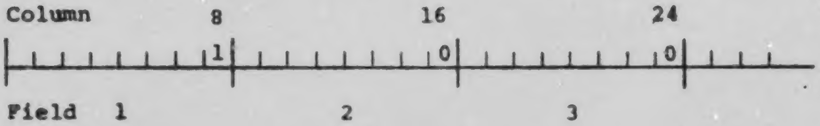
One of the stipulations regarding the development of this program was that it be operational on the CDC 3600 Computer. In order to satisfy this requirement, a modified version of the program was created. The modified version is identical to the basic program except for the input format and certain variations in the Fortran language. The latter are of no concern to the user. The purpose of the appendix is to describe the input format required by the modified version.

The primary difference between the input format in this version compared to the basic version of the program is that it is not free form as noted in Section 2.0. However, the organization of the input is identical. That is, there is a one-to-one correspondence between data cards except for overflow onto auxilary cards whenever all of the information for a given card (e.g. Card A) does not fit onto one card. This situation may arise whenever the elements of a vector are entered sequentially on a single card, such as "Card C" specified in Section 2.4.1,on which numerical values for the vector "HW" are punched.

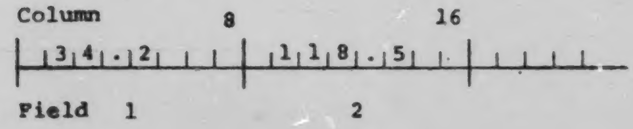
All of the input data for the CDC 3600 version must be entered in fields of eight (8) columns each. There may be as many as ten fields on any one card. Integer and floating point fields (Format I8 and E8.3) may occur on the same card. These are indicated by I of F as discussed in the main body of this manual. All interger values must be right justified in their particular fields. Floating point values may be punched anywhere in the field. Exponential format may be used for the latter. In this case, the exponent must be right justified, e.g. the number 29.0E3 must be written such that the "3" appears in the eighth column of the field.

The following examples illustrate the format requirements. These examples have been chosen from the Listing of Sample Data Input in Section 3.4.

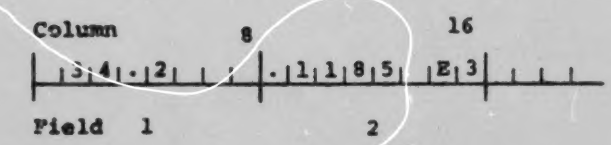
Example 1: Line 2 (Card B, Section 2.0)


Column
8
16
24
1
0
0
Field
1
2
3

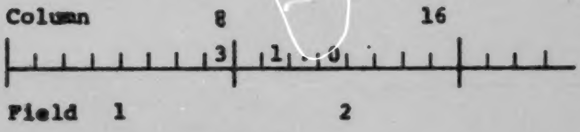
Example 2: Line 3 (Card C, Section 2.0)


Column
8
16
3 4 . 2
1 1 8 . 5
Field
1
2

Example 3: Line 3 (Card C, Section 2.0) Alternative format


Column
8
16
3 4 . 2
. 1 1 8 5
E 3
Field
1
2

Example 4: Line 10 (Card A, Section 2.1.1.2)


Column
8
16
3
1 . 0
Field
1
2

APPENDIX F

DETAILED ANALYTICAL METHOD - COMPUTER PROGRAM LISTING

This appendix contains a listing of the computer program used in the Detailed Analytical Method. The program is written in Fortran IV and is modularized to provide maximum flexibility for any future modification.

TABLE OF CONTENTS FOR COMPUTER PROGRAM

	Subroutine Call Statement Page (Row)	Subroutine Location Page (Row)
1. LOAD	F-4 (53)	
SEISMIC	F-32 (21)	F-48 (1)
SOILOD	F-32 (22)	F-73 (1)
WINDLOD	F-32 (24)	F-72 (1)
TRNLOD	F-32 (26)	F-67 (1)
2. STRUCT	F-35 (1)	
STIFF 3	F-35 (34)	F-31 (1)
STIFF 2	F-35 (37)	F-30 (1)
STIFF 1	F-35 (40)	F-33 (1)
READ 1	F-33 (45)	F-28 (1)
SFRAME	F-33 (53)	F-17 (1)
READ 2	F-33 (46)	F-15 (1)
GFRAME	F-34 (54)	F-21 (1)
CONDEN	F-34 (58)	F-13 (1)
FRMASS	F-34 (56)	F-23 (1)
FLMASS	F-35 (47)	F-6 (1)
EIGENS	F-35 (53)	F-9 (1)
3. DYNAMC	F-37 (1)	
DAMPR	F-37 (36)	F-32 (1)
SPECTR	F-38 (59)	F-26 (1)
COMPUTE MODAL RESPONSE	F-38 (70)	
COMPUTE TOTAL RESPONSE	F-38 (96)	
COMPUTE DUCTILITY	F-39 (136)	

	Subroutine Call Statement Page (Row)	Subroutine Location Page (Row)
4. STATIC	F-42 (1)	
INVERT STIFFNESS MATRIX	F-42 (16)	
DECOMP	F-42 (18)	F-9 (1)
INVERS	F-42 (19)	F-12 (1)
COMPUTE WIND PRESSURE	F-42 (25)	
WIND	F-42 (28)	F-58 (1)
TORNADO	F-42 (34)	F-67 (1)
COMPUTE WIND DEFLECTION	F-42 (39)	
COMPUTE INTERSTORY DRIFT AND SHEAR	F-43 (59)	
5. LSROOF	F-68 (1)	
DETAILED SWISS ANALYSIS	F-70 (120)	
GENERAL ANSI ANALYSIS	F-68 (51)	
GENERAL SWISS ANALYSIS	F-68 (35)	
COMPUTE PONDING LOAD	F-71 (201)	
6. DAMAG	F-44 (1)	
EARTHQUAKE DAMAGE	F-45 (103)	
WIND AND TORNADO DAMAGE	F-46 (151)	
LONG-SPAN ROOF DAMAGE	F-47 (197)	

```
      C      *****************************************************************
      C      *                                                               *
      C      *                                                               *
      C      *     METHODOLOGY FOR HAZARD RISK ANALYSIS OF BUILDINGS         *
      C      *                                                               *
      C      *     J H WIGGINS COMPANY                                       *
      C      *     1650 S PACIFIC COAST HWY                                  *
      C      *     REDONDO BEACH CALIFORNIA                                  *
      C      *     JULY 31, 1973                                             *
      C      *                                                               *
      C      *                                                               *
      C      *     THIS PROGRAM WAS DEVELOPED BY THE J H WIGGINS COMPANY FOR *
      C      *     THE U S NATIONAL BUREAU OF STANDARDS UNDER CONTRACT NO.   *
      C      *     3-35773. THE METHODOLOGY IS DESCRIBED IN A TECHNICAL REPORT *
      C      *     ACCOMPANIED BY A USERS MANUAL, BOTH OF WHICH WERE DELIVERED *
      C      *     WITH THE PROGRAM.                                         *
      C      *                                                               *
      C      *     THE PROGRAM PROVIDES BASIC TOOLS FOR EVALUATING THE       *
      C      *     DAMAGE TO BUILDINGS DUE TO EARTHQUAKE, WIND AND TORNADO.  *
      C      *     SITE LOADS CORRESPONDING TO THESE NATURAL HAZARDS ARE     *
      C      *     COMPUTED IN SUBROUTINE LOADS. BUILDING MODELS ARE GENERATED *
      C      *     IN SUBROUTINE STRUCT. RESPONSE IS COMPUTED IN SUBROUTINES *
      C      *     DYNAMC, STATIC AND LSROOF. DAMAGE PREDICTIONS ARE EVALUATED *
      C      *     IN SUBROUTINE DAMAG. A MORE DETAILED DESCRIPTION OF THE   *
      C      *     PROGRAM IS CONTAINED IN THE USERS MANUAL, ALONG WITH INPUT *
      C      *     AND OUTPUT SPECIFICATIONS.                                *
      C      *                                                               *
      C      *                                                               *
      C      *****************************************************************
             REAL M,LC(30),S(70,70),EDEFL(30)
             REAL CEC(10),CIC(10),QMS(30),VMM(30)
             DIMENSION NHAZ(3),T(100),F(100),C(70),D(70,70),H(30),
            &E(30,30),FA(30),FV(30),DRFT(30),TITLE(18)
         600 FORMAT('0INCLUDE EARTHQUAKE HAZARD:',3X,I1,/,
            &'0INCLUDE WIND HAZARD:',9X,I1,/,
            &'0INCLUDE TORNADO HAZARD:',6X,I1)
         610 FORMAT('0EXERCISE RISK OPTION:',8X,I1,/,
            &'0BUILDING MODELING OPTION:',6X,I1,/,
            &'0EVALUATE DAMAGE TO LONG-SPAN ROOF:',5X,I1)
         620 FORMAT('0SITE LOCATION: LATITUDE',F9.2,2X,
            &'DEGREES, LONGITUDE',F4.2,2X,'DEGREES')
             READ(5,588) (TITLE(I),I=1,18)
         588 FORMAT(18A4)
             WRITE(6,688) (TITLE(I),I=1,18)
         688 FORMAT('1RUN IDENTIFICATION:',//,13X,18A4)
             READ(5,9000) (NHAZ(I),I=1,3)
        9000 FORMAT( )
             WRITE(6,600) (NHAZ(I),I=1,3)
             READ(5,9000) DLAT,DLONG
             WRITE(6,620) DLAT,DLONG
             READ(5,9000) LRISK,NMOD,LSROPT
             WRITE(6,610) LRISK,NMOD,LSROPT
             CALL LOADS(DLAT,DLONG,LRISK,NHAZ,T,F,VF,ISITE,ISHAPE,VT,BL,ITOR,FI
     &,EM)
      IF((NHAZ(1).EQ.0).AND.(NHAZ(2).EQ.0).AND.(ITOR.NE.1)) GO TO 99
      CALL STRUCT(NMOD,NS,LC,TMB,TLB,PHR,NOPKT,$99,M,S,E,C,D)
      TI=6.283/SQRT(C(1))
      IF(NHAZ(1).EQ.0) GO TO 10
      CALL DYNAMC(NS,LC,S,C,D,M,AR,VR,T,F,E,LD,NOPKT,NMOD)
      DO 30 I=1,NS
      FA(I)=E(I,6)
      FV(I)=E(I,5)
      EDEFL(I)=E(I,4)
   30 CONTINUE
   10 IF(NHAZ(2).EQ.0) GO TO 20
  100 CONTINUE
      CALL STATIC(NHAZ,NS,S,LC,TMB,PHR,TI,DRFT,VT,
     &D,VF,M,CEC,CIC,QMS,VMM,ISHAPE,ISITE,NMOD,ITOR,ITYPE)
   20 CONTINUE
      IF(LSROPT.EQ.0) GO TO 40
      IF(ITOR.EQ.-1) GO TO 36
      TMB=0.
      DO 35 I=1,NS
   35 TMB=TMB+LC(I)
   36 PI=QMS(I)
      PI=VMM(I)
      CALL LSROOF(ITYPE,TLB,TMB,TMB-PI,PI,IFLY,IW)
   40 CONTINUE
      CALL DAMAG(NHAZ,EM,AM,VR,NS,FA,FV,EDEFL,LC,TI,DRFT,
     &CEC,CIC,QMS,VMM,ITOR,LSROPT,IFLY,IW)
      IF((NHAZ(3).NE.0).AND.(ITOR.GT.0)) GO TO 98
      GO TO 99
   98 ITOR=-1
      GO TO 100
   99 CONTINUE
      WRITE(6,700)
  700 FORMAT('0END OF JOB.')
      STOP
      END

@PRT,S  FLMASS
```

```
HASSELMAN-T.TPFS.FLMASS
            SUBROUTINE FLMASS(NS,M)
      C
      C  THIS SUBROUTINE READS FLOUR WEIGHT DATA FOR THE BUILDING,
      C  CONVERTS TO MASS, AND ADDS IT TO THE FRAMING MASS (IF ANY) FOR EACH
      C  STORY.
      C
            REAL M(30),FWT(30)
            READ(5,9000) (FWT(I),I=1,NS)
       9000 FORMAT ( )
            DO 10 I=1,NS
         10 M(I)=M(I)+FWT(I)/386.4
            RETURN
            END

@PRT,S  HOUSUR
```

```
HASSELMAN-T.TPFS.HOUSQR
      SUBROUTINE HOUSQR(N,G,E,X,A,B,PP)
          INTEGER N
         REAL E(70),G(70,70),X(70,70)
      INTEGER I,J,K,M,NQR,II,KI,NI                                        736.
      REAL T,ALFA,BETA,GAMMA,ABSB,R,S,C,W,H,BK,AINEW,P,Q,F,
     1     A(100),B(100),PP(100)                                          738.
      DOUBLE PRECISION SUM,SIGMA,DPRS
      DO 29 I=1,100                                                       739.
      A(I)=0.0                                                            740.
      B(I)=0.0                                                            741.
   29 PP(I)=0.0                                                           742.
      DO 1  I = 1,N                                                       744.
          II = I+1                                                        745.
          X(I,I) = 1                                                      746.
          DO 1  J = II,N                                                  747.
                X(I,J) = 0.0                                              748.
    1 X(J,I) = 0.0                                                        749.
      IF (N .GT. 1) GO TO 3                                               752.
      IF(N.NE.1) GUTO 2
                E(1) = G(1,1)                                             754.
                X(1,1) = 1.0                                              755.
    2     RETURN                                                          756.
    3 NI = N-2                                                            757.
      IF (N .EQ. 2) GO TO 165                                             758.
      DO 16  K = 1,NI                                                     759.
          KI = K+1                                                        761.
          A(K) = G(K,K)                                                   762.
          SIGMA = 0                                                       763.
          DO 4  I = KI,N                                                  764.
    4     SIGMA=SIGMA+G(I,K)**2
          IF (SIGMA .EQ. 0.0) GU TO 16                                    766.
          ABSB = DSQRT(SIGMA)
          ALFA = G(KI,K)                                                  768.
          IF (ALFA .GE. 0) GO TU 5                                        769.
                BETA = ABSB                                               770.
                GO TO 6                                                   771.
    5     BETA = -ABSB                                                    772.
    6     B(K) = BETA                                                     773.
          GAMMA = 1.0/(SIGMA - ALFA * BETA)                               774.
          G(KI,K) = ALFA - BETA                                           775.
          DO 9  I = KI,N                                                  776.
                SUM = 0                                                   777.
                IF (I .EQ. K) GO TO 75                                    778.
                DO 7  J = KI,I                                            779.
                DPRS = G(J,K)
    7           SUM = SUM + G(I,J) *     DPRS
   75           II = I+1                                                  781.
                IF (I .EQ. N) GO TO 9                                     782.
                DO 8  J = II,N                                            783.
                DPRS = G(J,K)
    8           SUM = SUM + G(J,I) * DPRS
    9     PP(I) = GAMMA * SUM                                             785.
          SUM = 0                                                         786.
      DO 10  I = K1,N                                        787.
      DPRS = G(I,K)
   10 SUM = SUM + DPRS * PP(I)
      T = 0.5 * GAMMA * SUM                                  789.
      DO 11  I = K1,N                                        790.
   11 PP(I) = PP(I) - T * G(I,K)                             791.
      DO 12  I = K1,N                                        792.
      DO 12  J = K1,N                                        793.
   12 G(I,J) = G(I,J) - G(I,K) * PP(J) - PP(I) * G(J,K)      794.
      DO 14  I = 2,N                                         795.
           SUM = 0                                           796.
           DO 13  J = K1,N                                   797.
           DPRS = G(J,K)
   13      SUM = SUM + X(I,J) * DPRS
   14 PP(I) = GAMMA * SUM                                    799.
      DO 15  I = 2,N                                         800.
      DO 15  J = K1,N                                        801.
   15 X(I,J) = X(I,J) - PP(I) * G(J,K)                       802.
   16 CONTINUE                                               803.
  165 N1 = N-1                                               804.
      A(N1) = G(N1,N1)                                       805.
      B(N1) = G(N,N1)                                        806.
      A(N)  = G(N,N)                                         807.
      NQR = 0                                                810.
      R = ABS(A(N))                                          814.
      DO 17  I = 1,N1                                        815.
           S = ABS(A(I))                                     816.
           IF (S .GT. R) R = S                               817.
           S = ABS(B(I))                                     818.
   17 IF (S .GT. R) R = S                                    819.
      IF (R .NE. 0.0) GO TO 19                               820.
           DO 18  I = 1,N                                    821.
   18      E(I) = C                                          822.
           RETURN                                            823.
   19 E(N) = A(N)                                            824.
      DO 20  I = 1,N1                                        829.
   20 E(I) = A(I)                                            830.
      K = N                                                  831.
   21 M = K                                                  832.
      IF (M .LE. 1) GO TO 28                                 833.
      T = ABS(E(K))                                          835.
      B(M) = 0                                               836.
   22 K = K-1                                                837.
           IF (K .LE. 0) GO TO 23                            838.
           S = B(K)                                          839.
           IF (T+S .EQ. T) GO TO 23                          840.
           T = ABS(E(K))                                     841.
           IF (T+S .EQ. T) GO TO 23                          842.
           GO TO 22                                          843.
   23 IF (K .EQ. M-1) GO TO 21                               844.
      K1 = K+1                                               845.
      T = 1                                                  850.
      S = E(M) - E(M-1)                                      851.
      R = B(M-1)                                             852.
      IF (ABS(R)+ABS(S) .EQ. ABS(R)) GO TO 24
          W = 2.0 * R / S
          T = W / (SQRT(W**2 + 1.0 ) + 1.D)
   24 NQR = NQR + M-K
      H = E(K1) - (E(M) + T * R)
      W = B(K1)
      BK = W
      T = SQRT(H ** 2 + W ** 2)
      GO TO 26
   25     T = SQRT(H ** 2 + W ** 2)
          B(K) = T
   26     K = K+1
          C = H / T
          S = W / T
          P = E(K)
          F = C * P + S * BK
          T = E(K+1)
          Q = C * BK + S * T
          BK = B(K+1)
          W = S * BK
          BK = C * BK
          AINEW = F * C + Q * S
          H = Q * C - F * S
          E(K+1) = (P+T) - AINEW
          E(K) = AINEW
          DO 27  J = 1,N
               P = X(J,K)
               Q = X(J,K+1)
               X(J,K) = C * P + S * Q
   27     X(J,K+1)=C*Q - S*P
          IF (K .LT. M-1) GO TU 25
      B(M-1) = H
      K = K+1
      GO TO 21
   28 NQR = NQR/N
      I=1
  201        Q=10.D**8
             DO 200 J=1,N
                  IF(E(J).GT.Q) GUTO 200
                  Q=E(J)
                  K=J
  200        CONTINUE
             IF(K.EQ.I) GOTO 203
             SUM=E(I)
             E(I)=E(K)
             E(K)=SUM
             DO 202 J=1,N
                  A(J)=X(J,I)
                  X(J,I)=X(J,K)
                  X(J,K)=A(J)
  202        CONTINUE
  203        I=I+1
      IF(I.LT.N) GOTO 201
      RETURN
```

```
                 END


@PRT,S  NORMAL



HASSELMAN-T*TPFS.NORMAL
                 SUBROUTINE NORMAL(N,DN)
                 REAL LARGE,DN(70,70)
                 DO 7 I=1,N
                 LARGE = 0.0
                 DO 5 J=1,N
               5 IF(ABS(DN(J,I)).GT.ABS(LARGE)) LARGE=DN(J,I)
                 DO 6 J=1,N
               6 DN(J,I)=DN(J,I)/LARGE
               7 CONTINUE
                 RETURN
                 END


@PRT,S  MATPRT



HASSELMAN-T*TPFS.MATPRT
                 SUBROUTINE MATPRT (M,N,A)
                 INTEGER RTCOL                                                675.
                 DIMENSION A(70,70)                                           676.
             601 FORMAT ('0')                                                 677.
             602 FORMAT (' ',1P7E10.2)
                 WRITE (6,601)                                                679.
                 NPAGES = (N-1)/7 + 1
                 DO 101 I=1,NPAGES                                            681.
                 WRITE(6,601)
                 LTCOL = 7*(I-1) + 1
                 RTCOL = 7*I
                 IF (RTCOL.GT.N) RTCOL=N                                      684.
                 DO 101 J=1,M                                                 685.
             101 WRITE (6,602) (A(J,K),K=LTCOL,RTCOL)                         686.
                 RETURN                                                       687.
                 END                                                          688.


@PRT,S  EIGENS
```

```
HASSELMAN-T*TPFS.EIGENS
            SUBROUTINE EIGENS(S,MT,M,CV,DN,N,A,B,PP)
            REAL S(70,70),MT(30),M(30),CV(70),DN(70,70)                   490.
            REAL A(100),B(100),PP(100)
            DO 2 I=1,N                                                    499.
          2 MT(I)=1.0/SQRT(M(I))                                          500.
            DO 3 J=1,N                                                    504.
            DO 3 K=1,N                                                    505.
          3 S(J,K)=S(J,K)*MT(J)*MT(K)
            CALL HOUSQR (N,S,CV,DN,A,B,PP)
            DO 4 J=1,N                                                    514.
            DO 4 K=1,N
          4 DN(J,K)=DN(J,K)*MT(J)                                         516.
            CALL NORMAL(N,DN)
            WRITE(6,608)                                                  529.
        608 FORMAT('1CHARACTERISTIC VECTORS',/)                           530.
            CALL MATPRT(N,N,DN)
            RETURN                                                        551.
            END                                                           552.


@PRT,S  DECOMP


HASSELMAN-T*TPFS.DECOMP
            SUBROUTINE DECOMP(N,A,$)
            DIMENSION A(70,70)                                            447.
            DOUBLE PRECISION SUM,DA
            DO 3 I=1,N                                                    449.
            DO 3 J=I,N                                                    450.
            SUM=A(I,J)                                                    451.
            KI=I-1
            IF(I.EQ.1)GOTO 1                                              453.
            DO 4 K=1,KI                                                   454.
            DA = A(K,J)                                                   455.
          4 SUM=SUM-A(K,I)*DA                                             456.
          1 IF(J.NE.I)GOTO 2                                              457.
            IF (SUM.LE.0.0) RETURN 3
            TEMP=1.0/DSQRT(SUM)                                           459.
            A(I,J)=TEMP                                                   460.
            GOTO 3                                                        461.
          2 A(I,J)=SUM*TEMP                                               462.
          3 CONTINUE                                                      463.
            RETURN                                                        464.
            END                                                           465.


@PRT,S  INVERS
```

```
HASSELMAN-T.TPFS.INVERS
             SUBROUTINE INVERS(N,U)                                467.
             DIMENSION U(70,70)
             DOUBLE PRECISION SUM,DU                               469.
             I1=N-1                                                470.
             DO 2 I=1,I1                                           471.
             J1=I+1                                                472.
             DO 2 J=J1,N                                           473.
             SUM=0.0                                               474.
             K1=J-1
             DO 1 K=1,K1                                           476.
             DU = U(K,J)                                           477.
           1 SUM=SUM-U(K,I)*DU                                     478.
           2 U(J,I)=SUM*U(J,J)                                     479.
             DO 4 I=1,N                                            480.
             DO 4 J=I,N                                            481.
             SUM=0.0                                               482.
             DO 3 K=J,N                                            483.
             DU = U(K,J)                                           484.
           3 SUM=SUM+U(K,I)*DU
             U(I,J)=SUM                                            486.
           4 U(J,I)=SUM                                            487.
             RETURN                                                488.
             END

@PRT,S  CONDEN
```

```
HASSELMAN-T.TPFS.CONDEN
          SUBROUTINE CONDEN(NB,NS,SN,S,S)
          INTEGER SN,NB2,NB22,NBSN,NB2N,NB21                         329.
          REAL SAB(20,20),S(70,70)
          DOUBLE PRECISION TEMP,DS
          NB2=2*NB+2                                                 334.
C                                                                    335.
C         INVENT S(AA)                                               336.
C                                                                    337.
          CALL DECOMP(NB2,S,$99)
          CALL INVERS (NB2,S)
C                                                                    340.
          IF(SN.EQ.NS) GOTO 20                                       341.
          DO 1 I=1,NB2                                               342.
          DO 1 J=1,NB2
        1 SAB(I,J)=S(I,J+NB2)
C                                                                    344.
C         S(AA)-1 * S(AB) STORED IN S(AB), S(AA)-1 * S(AF) STORED IN S(FA)
C                                                                    346.
          DO 2 I=1,NB2                                               347.
          DO 2 J=1,NB2                                               348.
          TEMP=0.0
          DO 22 K=1,NB2
          DS=SAB(K,J)
       22 TEMP=TEMP+S(I,K)*DS
        2 S(I,J+NB2)=TEMP
       20 CONTINUE                                                   350.
          NB22=2*NB2+1                                               351.
          NBSN=2*NB2+SN+1                                            352.
          IF(SN.EQ.NS) NBSN=2*NB2+SN
          DO 4 I=1,NB2                                               354.
          DO 4 J=NB22,NBSN                                           355.
          TEMP=0.0                                                   356.
          DO 3 K=1,NB2                                               357.
          DS = S(K,J)                                                358.
        3 TEMP=TEMP+S(I,K)*DS                                        359.
        4 S(J,I)=TEMP                                                360.
          IF(SN.EQ.NS) GOTO 21                                       361.
C                                                                    362.
C         S(BB)* = S(BB) - S(AB)T * S(AA)-1 * S(AB)                  363.
C                                                                    364.
          NB21=NB2+1                                                 365.
          NB2N=2*NB2                                                 366.
          DO 6 I=NB21,NB2N
          DO 5 J=NB21,NB2N
          TEMP=0.0
          DO 51 K=1,NB2
          DS=S(K,J)
       51 TEMP=TEMP+SAB(K,I-NB2)*DS
        5 S(I,J)=S(I,J)-TEMP
C                                                                    370.
C         S(BF)* = S(BF) - S(AB)T * S(AA)-1 * S(AF)                  371.
C                                                                    372.
          DO 6 I=NB21,NB2N                                           373.
```

```
      DO 6 J=NB22,NBSN                                          374.
      TEMP=0.0
      DO 61 K=1,NB2
      DS=S(J,K)
   61 TEMP=TEMP+SAB(K,I-NB2)*DS
    6 S(I,J)=S(I,J)-TEMP
   21 CONTINUE                                                  376.
C                                                               377.
C     S(FF)* = S(FF) - S(AF)T * S(AA)-1 * S(AF)                 378.
C                                                               379.
      DO 8 I=NB22,NBSN                                          380.
      DO 8 J=NB22,NBSN                                          381.
      TEMP =00.0                                                382.
      DO 7 K=1,NB2                                              383.
      DS = S(J,K)                                               384.
    7 TEMP = TEMP + S(K,I)*DS                                   385.
    8 S(I,J)=S(I,J)-TEMP                                        386.
      IF(SN.EQ.NS) GOTO 111
C                                                               388.
C     MOVE S(BB)* TO S(AA)  AND. S(BF)* TO S(AF)                389.
C                                                               390.
      DO 9 I=1,NB2                                              391.
      DO 9 J=1,NB2                                              392.
      S(I,J)=S(I+NB2,J+NB2)                                     393.
    9 S(I+NB2,J+NB2)=0.0                                        394.
      DO 10 I=1,NB2                                             395.
      DO 10 J=NB22,NBSN                                         396.
      S(I,J)=S(I+NB2,J)                                         397.
   10 S(I+NB2,J)=0.0                                            398.
  111 CONTINUE
      DO 12 I=1,NB2                                             410.
      DO 12 J=NB21,NB2N                                         411.
   12 S(I,J)=0.0
      GOTO 11                                                   413.
   99 RETURN 5
   11 CONTINUE                                                  415.
      RETURN                                                    416.
      END                                                       417.


@PRT,S  READ2
```

```
HASSELMAN-T.TPFS.READ2
          SUBROUTINE READ2(NB,NS,LC,NDLC ,NOPT)
          REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)                  10.
          REAL  AL(10),BL(10),FB(99),FC(99),
         $      ALB(200),BLB(200),SCJB(200),
         $     SCKB(200),ALC(220),BLC(220),SCJC(220),SCKC(220)
          INTEGER SUM
          INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
          COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
         $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
         $ ,AL,BL,FB,FC,G,EB,GB
          IF(NOPT.EQ.3) GOTO 105
          READ(5,9000) NB,NBT,NCT,E,G,EB,GB,WTB,WTC,NDLC
     9000 FORMAT ( )
          IF(EB .EQ. 0.0) EB=E
          IF(GB .EQ. 0.0) GB=G
          WRITE(6,501) NB,EB,GB,WTB,E,G,WTC
      501 FORMAT('0 NUMBER OF BAYS  =',I5,/,
         $ '0 BEAMS&    E=',F9.1,'  G=',F9.1,'  W(LBS/CU.FT)=',F9.2,/,
         $ '0 COLUMNS&  E=',F9.1,'  G=',F9.1,'  W(LBS/CU.FT)=',F9.2,/)
          IF(NBT.EQ.0) GOTO 73
          WRITE(6,601)                                                                   45.
      601 FORMAT('0BEAM TYPE          AB          IB          FB',/)
          DO 2 I=1,NBT
          READ(5,9000) J,B1,D1,ISECT
          IF(ISECT.GT.2) READ(5,9000) T1,T2
          GOTO(2001,2002,2003,2004),ISECT
     2001 AB(J)=B1*D1
          IB(J)=B1*D1**3/12.0
          FB(J)=1.20
          GOTO 2005
     2002 B1=B1/2.0
          AB(J)=3.1416*B1*B1
          IB(J)=3.1416*B1**4/4.0
          FB(J)=1.111111
          GOTO 2005
     2003 AB(J)=T1*(D1-2.*T2)+T2*2.*B1
          IB(J)=B1*D1**3/12.0-(B1-T1)*(D1-2.*T2)**3/12.0
          FB(J)=AB(J)/D1/T1
          GOTO 2005
     2004 AB(J)=T2*T1+B1*(D1-T1)
          Y=(B1*(D1-T1)**2/2.0+T2*T1*(D1-T1/2.0))/AB(J)
          IB(J)=B1*D1**3/12.0+(T2-B1)*T1**3/12.0+
         $      B1*D1*(D1/2.0-Y)**2+(T2-B1)*T1*(D1-T1/2.0-Y)**2
          FB(J)=AB(J)/(B1*D1)
     2005 WB(J)=AB(J)*WTB/1728./1000.
          WRITE(6,602)J,AB(J),IB(J),FB(J)
      602 FORMAT (I10,F12.1,F11.1,F11.2,F11.1,F10.3)
        2 CONTINUE
       73 IF(NCT.EQ.0) GOTO 74
          WRITE(6,603)
      603 FORMAT('0COLUMN TYPE        AC          IC          FC',/)
          DO 3 I=1,NCT
          READ(5,9000) J,B1,D1,ISECT
      IF(ISECT.GT.2)READ(5,9000) T1,T2
      GOTO (3001,3002,3003,3004),ISECT
 3001 AC(J)=B1*D1
      IC(J)=B1*D1**3/12.0
      FC(J)=1.20
      GOTO 3005
 3002 B1=B1/2.0
      AC(J)=3.1416*B1*B1
      IC(J)=3.1416*B1**4/4.0
      FC(J)=1.111111
      GOTO 3005
 3003 AC(J)=T1*(D1-2.*T2)+T2*2.*B1
      IC(J)=B1*D1**3/12.0-(B1-T1)*(D1-2.*T2)**3/12.0
      FC(J)=AC(J)/D1/T1
      GOTO 3005
 3004 AC(J)=T2*T1+B1*(D1-T1)
      Y=(B1*(D1-T1)**2/2.0+T2*T1*(D1-T1/2.0))/AC(J)
      IC(J)=B1*D1**3/12.0+(T2-B1)*T1**3/12.0+
     $      B1*D1*(D1/2.0-Y)**2+(T2-B1)*T1*(D1-T1/2.0-Y)**2
      FC(J)=AC(J)/(B1*D1)
 3005 WC(J)=AC(J)*WTC/1728./1000.
      WRITE(6,612)J,AC(J),IC(J),FC(J)
  612 FORMAT(I10,F12.1,F11.1,F11.2,2F11.1,F10.3)
    3 CONTINUE                                                          60.
   74 CONTINUE
      WRITE(6,604)                                                      65.
  604 FORMAT('0BAY WIDTHS -------',/)                                   66.
      SUM=0                                                             67.
    4 READ(5,9000)NUM,BW,BL1,AL2
      WRITE(6,605) NUM,BW
  605 FORMAT(I6,' BAYS AT',F10.3,' INCHES')                             71.
      J1=SUM+1                                                          72.
      J2=SUM+NUM                                                        73.
      DO 102 J=J1,J2                                                    74.
      BL(J)=BL1
      AL(J+1)=AL2
  102 LB(J)=BW                                                          75.
      SUM=SUM+NUM                                                       76.
      IF(SUM.LT.NB) GOTO 4                                              77.
  105 CONTINUE
      WRITE(6,606)                                                      78.
  606 FORMAT('CSTORY HEIGHTS -------',/)                                79.
      SUM=0                                                             80.
    5 READ(5,9000) NUM,SH
      WRITE(6,607)NUM,SH                                                82.
  607 FORMAT(I6,' STORIES AT',F10.3,' INCHES')                          83.
      J1=SUM+1                                                          84.
      J2=SUM+NUM                                                        85.
      DO 101 J=J1,J2                                                    86.
  101 LC(J)=SH                                                          87.
      SUM=SUM+NUM                                                       88.
      IF(SUM.LT.NS) GOTO 5                                              89.
      RETURN
      END                                                              250.

@PRT,S  SFRAME
```

```
HASSELMAN-T*TPFS.SFRAME
      SUBROUTINE SFRAME(NB,NS,LC,SN,S,NOPRT,NRFJ,NBB)
      REAL S(70,70),L
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)        253.
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     $ SCJC(220),SCKC(220)
     $ ,AL(10),BL(10),FB(99),FC(99)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      INTEGER B1,B2,BN,C1,C2,CN,BT,CT,SUM,SN,F1,F2                        256.
      SUM=0                                                               257.
      IFR=0
      A=0.0
      B=0.0
      SCJ=0.0
      SCK=0.0
      NC=NB+1
      R9=1.0
      IF(SN.EQ.NS) R9=0.0
      IF(NOPRT.NE.1)WRITE(6,600)SN
      IBTP=(SN-1)*NB
      ICTP=(SN-1)*(NB+1)
  600 FORMAT('0STORY NO.',I5,' -------STRUCTURE DATA',/,'0BEAM    AREA    260.
     *     IZ      B(DL) ',5X,'A',7X,'B',3X,'SCJ',5X,'SCK',/)
    1 IF(NRFJ.EQ.1) GOTO 80
      READ(5,9000)NUM,BT
 9000 FORMAT ( )
      GOTO 81
   80 READ(5,9000)NUM,BT,IFR,A,B,SCJ,SCK
   81 CONTINUE
      B1=SUM+1                                                            264.
      B2=SUM+NUM                                                          265.
      DO 2 BN=B1,B2                                                       266.
      L=LB(BN)-A-B
      SCM2=4.0*E*IB(BT)/L
      SCM3=1.5*SCM2/L
      SCM4=2.0*SCM3/L
      ALB(IBTP+BN)=A
      BLB(IBTP+BN)=B
      SCJB(IBTP+BN)=SCJ
      SCKB(IBTP+BN)=SCK
      BTP(IBTP+BN)=BT
      IF(IFR.EQ.1)GOTO 59
      EJ=0.0
      EK=0.0
      GOTO 60
   59 EJ=SCM2/4.0/SCJ
      EK=SCM2/4.0/SCK
   60 ES=12.0*EJ*EK+4.0*(EJ+EK)+1.0
      E1=EJ+EK+1.0
      E2J=2.0*EJ+1.0
      E2K=2.0*EK+1.0
      E3J=3.0*EJ+1.0
      E3K=3.0*EK+1.0
      IF(NOPRT.NE.1)WRITE(6,601)BN,AB(BT),IB(BT),JB(BT),A,B,SCJ,SCK
  601 FORMAT(I5,F9.1,F10.1,F9.5,2F8.2,1P2E9.2)
      J1=(BN-1)*2+1                                                    273.
      J2=J1+1                                                          274.
      K1=J2+1                                                          275.
      K2=K1+1                                                          276.
      S(J1,J1)=S(J1,J1)+SCM4*E1/ES
      S(J1,J2)=S(J1,J2)+SCM3*(E2K+2.0*(A/L)*E1)/ES
      S(J1,K1)=S(J1,K1)-SCM4*E1/ES
      S(J1,K2)=S(J1,K2)+SCM3*(E2J+2.0*B*E1/L)/ES
      S(J2,J2)=S(J2,J2)+SCM2*(E3K+3.0*(A/L)*(E2K+(A/L)*E1))/ES
      S(J2,K1)=S(J2,K1)-SCM3*(E2K+2.0*A*E1/L)/ES
      S(J2,K2)=S(J2,K2)+SCM2/2.0*(1.0+3.0*(A/L)*E2J+3.0*B/L*
     $E2K+6.0*A*B*E1/L/L)/ES
      S(K1,K1)=S(K1,K1)+SCM4*E1/ES
      S(K1,K2)=S(K1,K2)-SCM3*(E2J+2.0*B*E1/L)/ES
      S(K2,K2)=S(K2,K2)+SCM2*(E3J+3.0*B*(E2J+B*E1/L)/L)/ES
    2 CONTINUE
      SUM=SUM+NUM                                                      287.
      IF(SUM.LT.NR)GOTO 1                                              288.
      SUM=0                                                            289.
      F1=NC*4+SN
      F2=F1+1
      IF(SN.EQ.NS) F2=F1
      IF(NOPRT.NE.1)WRITE(6,602)
  602 FORMAT('0COLUMN                ',/)
    3 IF(NNFJ.EQ.1) GOTO 82
      READ(5,9000)NUM,CT
      GOTO 83
   82 READ(5,9000)NUM,CT,IFR,A,B,SCJ,SCK
   83 CONTINUE                                                         293.
      C1=SUM+1                                                         294.
      C2=SUM+NUM                                                       295.
      DO 4 CN=C1,C2
      L=LC(SN)-A-B
      SCM2=4.0*E*IC(CT)/L
      SCM3=1.5*SCM2/L
      SCM4=2.0*SCM3/L
      ALC(ICTP+CN)=A
      BLC(ICTP+CN)=B
      SCJC(ICTP+CN)=SCJ
      SCKC(ICTP+CN)=SCK
      CTP(ICTP+CN)=CT
      IF(IFR.EQ.1)GOTO 69
      EJ=0.0
      EK=0.0
      GOTO 70
   69 EJ=SCM2/4.0/SCJ
      EK=SCM2/4.0/SCK
   70 ES=12.0*EJ*EK+4.0*(EJ+EK)+1.0
      E1=EJ+EK+1.0
      E2J=2.0*EJ+1.0
      E2K=2.0*EK+1.0
      E3J=3.0*EJ+1.0
      E3K=3.0*EK+1.0
      IF(NOPRT.NE.1)WRITE(6,601)CN,AC(CT),IC(CT),WC(CT),A,B,SCJ,SCK
      J1=CN*3-1                                                      298.
      J2=J1+1                                                        299.
      K1=J1+NC*2                                                     300.
      K2=K1+1                                                        301.
      SCM1=E*AC(CT)/LC(SN)                                           304.
      S(F1,F1)=S(F1,F1)+SCM4*E1/ES
      S(J2,F1)=S(J2,F1)+SCM3*(E2K+2.0*A*E1/L)/ES
      S(J1,J1)=S(J1,J1)+SCM1                                         310.
      S(J2,J2)=S(J2,J2)+SCM2*(E3K+3.0*(A/L)*(E2K+(A/L)*E1))/ES
      IF(SN.EQ.NS) GOTO 4                                            312.
      S(K2,F1)=S(K2,F1)+SCM3*(E2J+2.0*B*E1/L)/ES
      S(J1,K1)=-SCM1                                                 314.
      S(J2,K2)=SCM2/2.0*(1.0+3.0*(A/L)*E2J+3.0*B/L*
     $E2K+6.0*A*B*E1/L/L)/ES
      S(K1,K1)=SCM1                                                  316.
      S(K2,K2)=SCM2*(E3J+3.0*B*(E2J+B*E1/L)/L)/ES
      S(F1,F2)=S(F1,F2)-SCM4*E1/ES
      S(F2,F1)=S(F1,F2)
      S(J2,F2)=-SCM3*(E2K+2.0*A*E1/L)/ES
      S(K2,F2)=-SCM3*(E2J+2.0*B*E1/L)/ES
      S(F2,F2)=S(F2,F2)+SCM4*E1/ES
    4 CONTINUE                                                       323.
      SUM=SUM+NUM
      IF(SUM.LT.NB+1) GOTO 3
      IF(NBB.EQ.0) GOTO 91
      IF(NOPRT .NE. 1) WRITE(6,603)
  603 FORMAT('OBRACE    AREA       AREA',/)
      DO 4 I=1,NBB
      READ(5,9000) BN,BT,CT
      BBTP1(IBTP+BN)=BT
      BBTP2(IBTP+BN)=CT
      L=SQRT(LB(BN)**2+LC(SN)**2)
      J1=BN*2-1
      J2=(BN+1)*2-1
       K1=J1+NC*2
      K2=J2+NC*2
      CX=LB(BN)/L
      CY=LC(SN)/L
      SCM1=E*ABR(BT)/L
      SCM2=E*ABR(CT)/L
      S(F2,F2)=S(F2,F2) + CX*CX*R9*(SCM1+SCM2)
      S(F2,F1)=S(F2,F1) - CX*CX*R9*(SCM1+SCM2)
      S(K1,F2)=S(K1,F2) + CX*CY*R9*SCM1
      S(K1,K1)=S(K1,K1) + CY*CY*R9*SCM1
      S(K1,F1)=S(K1,F1) - CX*CY*R9*SCM1
      S(F1,F2)=S(F1,F2) - CX*CX*R9*(SCM1+SCM2)
      S(F1,F1)=S(F1,F1) + CX*CX*(SCM1+SCM2)
      S(J2,F2)=S(J2,F2) - CX*CY*R9*SCM1
      S(J2,K1)=S(J2,K1) - CY*CY*R9*SCM1
      S(J2,F1)=S(J2,F1) + CX*CY*SCM1
      S(J2,J2)=S(J2,J2) + CY*CY*SCM1
      CY=-CY
      S(J1,F1)=S(J1,F1) + CX*CY*SCM2
      S(J1,J1)=S(J1,J1) + CY*CY*SCM2
      S(J1,F2)=S(J1,F2) - CX*CY*R9*SCM2
      S(J1,K2)=S(J1,K2) - CY*CY*R9*SCM2
      S(K2,F1)=S(K2,F1) - CX*CY*R9*SCM2
      S(K2,F2)=S(K2,F2) + CX*CY*R9*SCM2
      S(K2,K2)=S(K2,K2) + CY*CY*R9*SCM2
      IF(NOPRT.NE.1) WRITE(6,601) BN,ABR(BT),ABR(CT)
    9 CONTINUE
   91 CONTINUE
      RETURN
      END
```

327.

```
@PRT,S GFRAME
```

```
HASSELMAN-T*TPFS.GFRAME
          SUBROUTINE GFRAME(NB,NS,LC,SN,S,NOPRT)
          REAL S(70,70),L,AL(10),BL(10),FB(99),FC(99)
          REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)         253.
         $ ,ALB(200),BLB(200),SCJB(200),SCKB(200),
         $ ALC(220),BLC(220),SCJC(220),SCKC(220)
          INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
          COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
         $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
         $ ,AL,BL,FB,FC,G,EB,GB
          INTEGER B1,B2,SN,C1,C2,CN,BT,CT,SUM,SN,F1,F2                         256.
          SUM=0                                                                257.
          NC=NB+1                                                              258.
          IF(NOPRT.NE.1)WRITE(6,600)SN
          IBTP=(SN-1)*NB
           ICTP=(SN-1)*(NB+1)
      600 FORMAT('0STORY NO.',I5,' -------STRUCTURE DATA',/,'0BEAM    AREA      260.
         *       IZ     #(DL) ',5X,'BL1',7X,'AL1',/)
        1 READ(5,9000) NUM,BT
     9000  FORMAT ( )
          B1=SUM+1                                                             264.
          B2=SUM+NUM                                                           265.
          DO 2 BN=B1,B2                                                        266.
          L=LB(BN)-BL(BN)-AL(BN+1)
          BTP(IBTP+BN)=BT
          IF(NOPRT.NE.1)WRITE(6,601)BN,AB(BT),IB(BT),WB(BT),BL(BN),AL(BN+1)
      601 FORMAT(I5,2F10.1,F10.5,2F10.2)
          G1=6.0*FB(BT)*EB*IB(BT)/GB/AB(BT)/L/L
          SCM2=4.0*EB*IB(BT)/L/(1.0+2.0*G1)
          SCM3=1.5*SCM2/L
          SCM4=2.0*SCM3/L
          J1=(BN-1)*2+1                                                        273.
          J2=J1+1                                                              274.
          K1=J2+1                                                              275.
          K2=K1+1                                                              276.
          B=AL(BN+1)
          A=BL(BN)
          S(J1,J1)=S(J1,J1)+SCM4                                               277.
          S(J1,J2)=S(J1,J2)+SCM3*(1.0+2.0*A/L)
          S(J1,K1)=S(J1,K1)-SCM4                                               279.
          S(J1,K2)=S(J1,K2)+SCM3*(1.0+2.0*B/L)
          S(J2,J2)=S(J2,J2)+SCM2*(1.0+3.0*(A/L)*(1.0+A/L))*(1.0+G1/2.0)
          S(J2,K1)=S(J2,K1)-SCM3*(1.0+2.0*A/L)
          S(J2,K2)=S(J2,K2)+SCM2/2.0*(1.0+3.0*(A/L)+3.0*(B/L)+
         $                 6.0*A*B/L/L)*(1.0-G1)
          S(K1,K1)=S(K1,K1)+SCM4                                               284.
          S(K1,K2)=S(K1,K2)-SCM3*(1.0+2.0*B/L)
          S(K2,K2)=S(K2,K2)+SCM2*(1.0+3.0*(B/L)*(1.0+B/L))*(1.0+G1/2.0)
        2 CONTINUE
          SUM=SUM+NUM                                                          287.
          IF(SUM.LT.NB)GOTO 1                                                  288.
          SUM=0                                                                289.
          IF(NOPRT.NE.1)WRITE(6,602)
      602 FORMAT('0COLUMN  AREA         IZ     #(DL)',/)                        291.
```

```
    3 READ(5,9002) NUM,CT
      C1=SUM+1
      C2=SUM+NUM
      DO 4 CN=C1,C2
      CTP(ICTP+CN)=CT
      IF(NUPRT.NE.1)WRITE(6,631)CN,AC(CT),IC(CT),AC(CT)
      J1=CN*2-1
      J2=J1+1
      K1=J1+NC*2
      K2=K1+1
      F1=NC*4+SN
      F2=F1+1
      SCM1=E*AC(CT)/LC(SN)
      G1=6.0*FC(CT)*E*IC(CT)/G/AC(CT)/LC(SN)/LC(SN)
      SCM2=4.0*E*IC(CT)/LC(SN)/(1.0+2.0*G1)
      SCM3=1.5*SCM2/LC(SN)
      SCM4=2.0*SCM3/LC(SN)
      S(F1,F1)=S(F1,F1)+SCM4
      S(J2,F1)=S(J2,F1)+SCM3
      S(J1,J1)=S(J1,J1)+SCM1
      S(J2,J2)=S(J2,J2)+SCM2*(1.0+G1/2.0)
      IF(SN.EQ.NS) GOTO 4
      S(K2,F1)=S(K2,F1)+SCM3
      S(J1,K1)=-SCM1
      S(J2,K2)=SCM2/2.0*(1.0-G1)
      S(K1,K1)=SCM1
      S(K2,K2)=SCM2*(1.0+G1/2.0)
      S(F1,F2)=S(F1,F2)-SCM4
      S(F2,F1)=S(F2,F1)-SCM4
      S(J2,F2)=-SCM3
      S(K2,F2)=-SCM3
      S(F2,F2)=S(F2,F2)+SCM4
    4 CONTINUE
      SUM=SUM+NUM
      IF(SUM.LT.NB+1) GOTO 3
      RETURN
      END


@PRT,S  FRMASS
```

```
MASSELM,N-T*TPFS.FRMASS
              SUBROUTINE FRMASS(M,SN,LC,NB,NOPRT)
              REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
              INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
              REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
             & SCJC(220),SCKC(220)
             & ,AL(10),BL(10),FB(99),FC(99)
              REAL M(30)
              COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
             & SCKB,ALC,BLC,SCJC,SCKC,SU(99),SC(99),BBTP1,BBTP2,ABR(20)
             & ,AL,BL,FB,FC,G,EB,GB
              INTEGER SN,BN,CN,BT,CT
              NC=NB+1
              G=386.4
       9000   FORMAT ( )
         601  FORMAT('OTOTAL WEIGHT OF STORY FRAMING =',F15.3,' KIPS')
              IBTP=(SN-1)*NB
              DO 1 BN=1,NB
              BT=BTP(IBTP+BN)
            1 M(SN)=M(SN)+WB(BT)*LB(BN)/G
              ICTP=(SN-1)*NC
              DO 2 CN=1,NC
              CT=CTP(ICTP+CN)
              M(SN)=M(SN)+AC(CT)*LC(SN)/2.0/G
              IF(SN.EQ.1) GOTO 2
              CT=CTP(ICTP+CN)
              M(SN)=M(SN)+AC(CT)*LC(SN-1)/2.0/G
            2 CONTINUE
              WTL = M(SN)*G
              IF(NOPRT.NE.1)WRITE(6,601) WTL
              RETURN
              END

@PRT,S  SDATA
```

```
HASSELMAN-T.TPFS.SDATA
      SUBROUTINE SDATA
      REAL LB(10),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
     $       ,AL(10),BL(10),FB(99),FC(99)
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     $ SCJC(220),SCKC(220)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC ,BBTP1,BBTP2,ABR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      DATA AB
     1/ 7.67,9.13,10.6,11.8,13.3,14.7,17.1,18.8,20.9,23.0,25.9,28.2,
     2  10.3,11.8,13.2,14.7,16.2,17.7,18.9,20.6,22.7,25.0,28.2,30.9,
     3  33.5,13.0,14.4,16.2,18.3,20.0,21.5,24.2,28.3,33.0,37.4,41.8,
     4  16.2,18.0,20.0,22.4,24.7,27.7,29.5,32.5,35.4,38.3,42.7,47.1,
     5  24.8,27.7,30.0,33.6,42.7,47.1,52.2,29.1,31.8,34.2,36.5,38.9,
     6  50.7,56.3,61.9,34.8,38.3,41.6,44.8,58.9,64.8,70.6,39.8,44.2,
     7  47.1,50.0,53.6,57.2,67.7,72.1,76.5,82.4,88.3,100.,0.00/
      DATA IB
     1/ 300.,374.,447.,517.,584.,657.,748.,836.,941.,1050.,1220.,
     2  1360.,513.,612.,706.,802.,891.,986.,1050.,1160.,1290.,1440.,
     3  1680.,1850.,2040.,843.,971.,1140.,1330.,1480.,1600.,1760.,
     4  2100.,2620.,3020.,3410.,1340.,1540.,1820.,2100.,2370.,2690.,
     5  3000.,3330.,3650.,4020.,4570.,5120.,2830.,3270.,3610.,4090.,
     6  5430.,6030.,6740.,4000.,4470.,4930.,5360.,5760.,7910.,8850.,
     7  9890.,5900.,6710.,7460.,8160.,11100.,12300.,13600.,7820.,
     8  9030.,9760.,10500.,11300.,12100.,15000.,16100.,17300.,
     9  18900.,20300.,1.,1./
      DATA WB
     1/ 26.,31.,36.,40.,45.,50.,58.,64.,71.,78.,88.,96.,35.,40.,45.,
     2  50.,55.,60.,64.,70.,77.,85.,96.,105.,114.,44.,49.,55.,62.,68.,
     3  73.,82.,96.,112.,127.,142.,55.,61.,68.,76.,84.,94.,100.,110.,
     4  120.,130.,145.,160.,84.,94.,102.,114.,145.,160.,177.,99.,108.,
     5  116.,124.,132.,172.,190.,210.,118.,130.,141.,152.,200.,220.,
     6  240.,135.,153.,160.,170.,182.,194.,230.,245.,260.,280.,300.,
     7  0.,0./
      DATA AC
     1/ 17.9,20.0,21.8,22.9,24.7,25.6,27.9,30.3,32.7,35.0,37.3,
     2  40.0,41.8,44.1,46.5,49.1,51.7,54.1,56.7,59.4,62.1,64.4,
     3  67.1,69.7,72.3,77.6,84.4,92.3,101.,109.,117.,125.,134.,
     4  147.,162.,178.,196.,215.,1.00/
      DATA IC
     1/ 691.0,724.0,797.0,851.0,928.0,967.0,1060.,1170.,1270.,1370.,
     2  1480.,1590.,1670.,1790.,1900.,2020.,2150.,2270.,2400.,2540.,
     3  2670.,2800.,2940.,3080.,3230.,3530.,3910.,4400.,4910.,5450.,
     4  6010.,6610.,7220.,8250.,9450.,10900.,12500.,14400.,1.00,1140.0,
     5  107.0,121.0,133.0,207.0,225.0,350.0,384.0,420.0,455.0,492.0,
     6  528.0,568.0,660.0,703.0,745.0,793.0,838.0,883.0,930.0,980.0,
     7  1030.,1070.,1120.,1170.,1230.,1330.,1470.,1630.,1810.,1990.,
     8  2170.,2360.,2560.,2880.,3260.,3680.,4170.,4720.,1.000/
      DATA WC
     1/ 61.0,68.0,74.0,78.0,84.0,87.0,95.0,103.,111.,119.,127.,
     2  136.,142.,150.,158.,167.,176.,184.,193.,202.,211.,219.,
     3  228.,237.,246.,264.,287.,319.,342.,370.,398.,426.,455.,
     4  500.,550.,605.,665.,730.,0.00/
        DO 10 I=1,38
        I2=50+I
        WC(I)=WC(I)/1000.0/12.0
        AC(I2)=AC(I)
        WC(I2)=WC(I)
   10   CONTINUE
        DO 20 I=1,81
   20   WB(I)=WB(I)/1000.0/12.0
        DO 21 I=1,99
        FB(I)=0.0
   21   FC(I)=0.0
        RETURN
        END

@PRT,S  SPECTR
```

```
HASSELMAN-T.TPFS.SPECTR
      SUBROUTINE SPECTR(TI,EMU,T,F,BETA,ASR,VSR,SV,SVF,SVD,LD)
C
C  THIS SUBROUTINE INTERPOLATES LINEARLY BETWEEN POINTS DEFINED ON THE
C  GROUND SITE VELOCITY SPECTRUM AND THEN MULTIPLIES RESULT-
C  ING SPECTRAL VELOCITY BY A DYNAMIC AMPLIFICATION FACTOR.
C  IF SPECTRAL VELOCITY IS TO BE MODIFIED TO ACCOUNT FOR DUCTILITY,
C  LD .NE. ZERO, THEN THE MODAL PERIOD IS CHANGED AND TWO SEPARATE
C  SPECTRAL VELOCITIES ARE COMPUTED. SVF IS TO BE USED TO COMPUTE ACCELERATION
C  DEPENDENT QUANTITIES INCLUDING FORCE, AND SVD IS TO BE USED TO COMPUTE DIS-
C  PLACEMENT DEPENDENT QUANTITIES INCLUDING DEFLECTION AND PSEUDO VELOCITY.
C
      REAL T(100),F(100)
      IF(LD.EQ.0) GO TO 11
      IF(EMU.LT.1.) GO TO 11
      TI=TI*(.75*ASIN(1./SQRT(2.*EMU-1.))/6.283+SQRT(2.*(EMU-1.))/6.283)
   11 CONTINUE
      IF(TI.LT.T(1)) TI=T(1)
      DO 10 I=1,500
      K=I+1
      IF ((TI.LE.T(K)) .AND. (TI.GE.T(I))) GO TO 15
   10 CONTINUE
   15 Y=F(K)-F(I)
      X=T(K)-T(I)
      IF(X.LT..001) X=0.001
      Z=TI-T(I)
      SLOPE=Y/X
      SV=F(I)+Z*SLOPE
C
C  MODIFY SPECTRAL VELOCITY FOR ELASTIC STRUCTURAL AMPLIFICATION
C
      TA=ALOG10(TI)
      TB=ALOG10(BETA)
  600 FORMAT('0TA = ',E12.4,5X,'TB = 'E12.4)
      IF(TI.LT.0.2) GO TO 20
      AFB=2.18-.147*TA-.633*TB
      GO TO 25
   20 AFB=(2.28-.633*TB)*TI/.2
   25 CONTINUE
      IF(AFB.LT.1.0) AFB=1.0
   23 FORMAT(1H0,2X,'AFB =',E12.4)
   21 FORMAT(1H0,2X,'SV =',E12.4)
      SV=SV*AFB
   22 FORMAT(1H0,2X,'SV*AFB =',E12.4)
      IF (LD.EQ.0) GO TO 140
      IF(EMU.LT.1.) GO TO 140
C
C  MODIFY SPECTRAL VELOCITY FOR DUCTILITY
C
      TA1=6.283*VSR/ASR/386.4
      SREMU=SQRT(EMU)
      TA2=TA1/SREMU
      IF(TI.GT.TA2) GO TO 120
      SVF=SV/SREMU
      SVD=SV*SREMU
      GO TO 150
  120 IF(TI.GT.TA1) GO TO 130
      SVF=SV*(1.-(TI-TA2)/TA1)/SREMU
      SVD=SV*(1.-(TI-TA2)/TA1)*SREMU
      GO TO 150
  130 SVF=SV/EMU
      SVD=SV
      GO TU 150
  140 CONTINUE
      SVF=SV
      SVD=SV
  150 RETURN
      END

@PRT,S  READ1
```

```
HASSELMAN-T.TPFS.READ1
      SUBROUTINE READ1(NB,NS,LC,NBB,NRFJ,NDLC )
      REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)          14.
      REAL  AL(10),BL(10),FB(99),FC(99)
      INTEGER SUM
      INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
      REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
     $ SCJC(220),SCKC(220)
      COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
     $ SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
     $ ,AL,BL,FB,FC,G,EB,GB
      READ(5,9000) E,NB,NBT,NCT,NBB,NBRT,NRFJ,NDLC
 9000 FORMAT ( )
      WRITE(6,673)NB,NBB,E
  673 FORMAT('0NUMBER OF BAYS        =',I5,/
     $        '0NUMBER OF BRACED BAYS =',I5,/,
     $        '0YOUNGS MODULUS        =',F9.1,3X,'(KIPS/SQ IN)',/)
      IF(NBT.LE.0) GOTO 73
      WRITE(6,601)                                                          45.
  601 FORMAT('0BEAM TYPE         AB          IB          WB',/)             46.
      DO 2 I=1,NBT                                                          47.
      READ(5,9000)J,AB(J),IB(J),WB(J)
      WRITE(6,602)J,AB(J),IB(J),WB(J)                                       50.
  602 FORMAT(I10,F13.1,F10.1,F10.2)                                         51.
      WB(J) = WB(J)/1000.0/12.0                                             52.
    2 CONTINUE                                                              53.
   73 IF(NCT.LE.0) GOTO 74
      WRITE(6,603)                                                          54.
  603 FORMAT('0COLUMN TYPE       AC          IC          WC',/)             55.
      DO 3 I=1,NCT                                                          56.
      READ(5,9000)J,AC(J),IC(J),WC(J)
      WRITE(6,602)J,AC(J),IC(J),WC(J)                                       58.
      WC(J) = WC(J)/1000.0/12.0                                             59.
    3 CONTINUE                                                              60.
   74 CONTINUE
      IF(NBRT.EQ.0) GOTO 77
      DO 75 I=1,200
      BBTP1(I)=0
   75 BBTP2(I)=0
      WRITE(6,609)
      DO 76 I=1,NBRT
      READ(5,9000) J,ABR(J)
   76 WRITE(6,602) J,ABR(J)
  609 FORMAT ('0BRACE TYPE      ABR',/)
   77 CONTINUE
      WRITE(6,604)
 604  FORMAT('0BAY WIDTHS ------',/)
      SUM=0                                                                 67.
    4 READ(5,9000)NUM,BW
      WRITE(6,605)NUM,BW
  605 FORMAT(I6,' BAYS AT',F10.3,' INCHES')                                 71.
      J1=SUM+1                                                              72.
      J2=SUM+NUM                                                            73.
      DO 102 J=J1,J2                                                        74.
```

```
102 LB(J)=80
    SUM=SUM+NUM
    IF(SUM.LT.NB) GOTO 4
    WRITE(4,606)
606 FORMAT('0STORY HEIGHTS --------',/)
    SUM=0
  5 READ(5,9003) NUM,SH
    WRITE(6,607)NUM,SH
607 FORMAT(I6,' STORIES AT',F10.3,' INCHES')
    J1=SUM+1
    J2=SUM+NUM
    DO 101 J=J1,J2
101 LC(J)=SH
    SUM=SUM+NUM
    IF(SUM.LT.NS) GOTO 5
    RETURN
    END

@PRT,S  STIFF2
```

```
MASSELM,N-T.TPFS.STIFF2
      SUBROUTINE STIFF2(NS,S,LC)
C
C     THIS SUBROUTINE READS CARD INPUT FOR GENERATING THE STIFFNESS
C     MATRIX OF A STORY MODEL OF A BUILDING AND PRODUCES AN NXN
C     STIFFNESS MATRIX WHERE N = NUMBER OF STORIES.
C
      REAL S(70,70),SK(30),LC(30)
      WRITE(6,10)
   10 FORMAT('0STIFFNESS INPUT FOR STORY MODEL - NBOPT = 2')
      READ(5,9000)(SK(I),I=1,NS)
      READ(5,9000) (LC(I),I=1,NS)
 9000 FORMAT( )
      WRITE(6,30)
   30 FORMAT('0STORY',' STIFFNESS(KIPS/IN)')
      DO 40 I=1,NS
   40 WRITE(6,50)NS,SK(I)
   50 FORMAT(1H ,I5,E20.9)
      WRITE(6,600) (LC(I),I=1,NS)
  600 FORMAT('0STORY HEIGHTS, TOP TO BOTTOM (INCHES)',//,3(1X,1P10E10.2,
     6/))
C
C     COMPUTE STIFFNESS MATRIX S
C
      S(1,1)=SK(1)
      IF(NS.EQ.1) GO TO 62
      S(2,1)=-SK(1)
      NSM1=NS-1
      DO 60 I=2,NSM1
      S(I-1,I)=-SK(I-1)
      S(I,I)=SK(I-1)+SK(I)
      S(I+1,I)=-SK(I)
   60 CONTINUE
      S(NS-1,NS)=S(NS,NS-1)
      S(NS,NS)=SK(NS)+SK(NS-1)
   62 CONTINUE
      RETURN
      END

@PRT,S  STIFF3
```

```
HASSELMAN-T*TPFS.STIFF3
      SUBROUTINE STIFF3(NS,LC,TI,CV,DN)
C
C  THIS SUBROUTINE READS THE NUMBER OF STORIES AND STORY HEIGHTS
C  OF A BUILDING AND ITS FUNDAMENTAL PERIOD, TI. IT THEN CUMPUTES MODAL
C  DEFLECTIONS ASSUMING A STRAIGHT-LINE MODE SHAPE FOR THE FUNDAMENTAL
C  MODE AND EVALUATES THE FUNDAMENTAL EIGENVALUE BASED ON THE PERIOD
C  SPECIFIED.
C
      DIMENSION CV(70),DN(70,70)
      REAL LC(30)
  600 FORMAT('0NUMBER OF STORIES = ',I5)
 9000 FORMAT( )
      READ(5,9000) TI
      WRITE(6,620) TI
  620 FORMAT('0FUNDAMENTAL PERIUD (SEC) =',F8.3)
      READ(5,9003) (LC(I),I=1,NS)
      WRITE(6,610) (LC(I),I=1,NS)
  610 FORMAT('CSTORY HEIGHTS, TOP TO BOTTOM',//,
     63(1X,1P10E10.2,/))
4     SUM1=0.0
      DO 200 I=1,NS
200   SUM1=SUM1+LC(I)
      DN(1,1)=1.00
      SUM2=0.0
      DO 201 I=2,NS
      SUM2=SUM2+LC(I-1)
201   DN(I,1)=1.0*(SUM1-SUM2)/SUM1
      CV(1)=(6.2831853/TI)**2
      RETURN
      END

@PRT,S  LOADS
```

```
HASSELMAN-T*TPFS.LOADS
          SUBROUTINE LOADS(DLAT,DLONG,LRISK,NHAZ,T,F,VF,ISITE,ISHAPE,VT,
         &BL,ITOR,F1,EM)
C
C  THIS SUBROUTINE GENERATES SITE LOADS FOR THREE NATURAL HAZARDS.
C
C     EARTHQUAKE: SITE LOAD IS DEFINED TO BE THE GROUND
C                 PSEUDO-VELOCITY SPECTRUM COMPUTED FROM
C                 A BASE-ROCK SPECTRUM AND MODIFIED BY SITE SOIL
C                 CHARACTERISTICS.
C
C     WIND:       SITE LOAD IS DEFINED TO BE THE FASTEST MILE OF WIND
C                 AT 30 FEET FOR OPEN EXPOSURE.
C
C     TORNADO:    SITE LOAD IS DEFINED IN TERMS OF PROBABILITY OF HIT
C                 AND, IF DESIRED, A NOMINAL TORNADO WIND VELOCITY
C                 SPECIFIED BY THE USER.
C
      INTEGER NHAZ(3)
      REAL T(100),F(100)
      IF(NHAZ(1).EQ.0) GO TO 10
      CALL SEISMC(LRISK,DLAT,DLONG,EM,AR,VR,DR)
      CALL SOILOD(AR,VR,DR,F,T)
   10 IF(NHAZ(2).EQ.0) GO TO 20
      CALL WNDLOD(ISITE,ISHAPE,VF)
   20 IF(NHAZ(3).EQ.0) GO TO 30
      CALL TRNLOD(DLAT,DLONG,VT,ITOR)
   30 CONTINUE
      RETURN
      END


@PRT,S  DAMPR


HASSELMAN-T*TPFS.DAMPR
      SUBROUTINE DAMPR(NDAMP,EMU,ZETA)
      ZETA=2.16+5.2*EMU-.74*EMU**2
      EMUM=5.2/1.44
      ZETAM=2.16+5.2*EMUM-.74*EMUM**2
      IF (EMU.GT.EMUM) ZETA=ZETAM
      IF(NDAMP.EQ.2) ZETA=2.*ZETA
      RETURN
      END


@PRT,S  STIFF1
```

```
MASSELMAN-T0TPFS.STIFF1
            SUBROUTINE STIFF1(NOPT,NS,LC,S,M,B,NOPRT)
      C
      C  THIS SUBROUTINE READS DETAILED STRUCTURAL DATA AND COMPUTES
      C  A REDUCED STIFFNESS MATRIX CORRESPONDING TO FLOOR
      C  TRANSLATIONS. WHEN NOLC .NE. 1, A MASS VECTOR IS COMPUTED TO
      C  ACCOUNT FOR THE MASS OF STEEL FRAMING ONLY.
      C
            REAL LB(10),LC(30),AB(99),AC(99),IB(99),IC(99),WB(99),WC(99)
            REAL S(70,70),M(30),
           6     AL(10),BL(10),FB(99),FC(99)
            INTEGER SN,FRN
            INTEGER BTP(200),CTP(220),BBTP1(200),BBTP2(200)
            REAL ALB(200),BLB(200),SCJB(200),SCKB(200),ALC(220),BLC(220),
           6 SCJC(220),SCKC(220)
            COMMON /DATA/ BTP,CTP,LB,AB,AC,IB,IC,E,WB,WC,ALB,BLB,SCJB,
           6 SCKB,ALC,BLC,SCJC,SCKC,BBTP1,BBTP2,ABR(20)
           6 ,AL,BL,FB,FC,S,EB,GB
            REAL ST(30,30),D(30,30)
      C*****************************************************************
      C  INPUT PARAMETERS
      C*****************************************************************
            CALL SDATA
            NDIM=70
      9000  FORMAT ( )
            FRN=0
            DO 22 I=1,30
            M(I)=0.0
            DO 22 J=1,30
            ST(I,J)=0.0
      22    D(I,J)=0.0
            READ(5,9000) NFRMS
            WRITE(6,687) NFRMS
      687   FORMAT('0NUMBER OF FRAMES  = ',I5,/)
      2     FRN=FRN+1
            READ(5,9000) NOPT
            WRITE(6,686) FRN,NOPT
      686   FORMAT('0*** FRAME NO.',I3,' ***',' FRAME MODELING OPTION =',I5,
           6//)
            DO 3 I=1,NDIM
            DO 3 J=1,NDIM
      3     S(I,J)=0.0
      C*****************************************************************
      C  DEFINE STRUCTURE PARAMETERS
      C*****************************************************************
            IF(NOPT.EQ.1) CALL READ1(NB,NS,LC,NBB,NRFJ,NOLC )
            IF(NOPT.EQ.2) CALL READ2(NB,NS,LC,NOLC ,NOPT)
      C*****************************************************************
      C  GENERATE STIFFNESS MATRIX AND FRAMING MASS MATRIX.
      C  ELIMINATE VERT. TRANS. AND ROTAT. BY STATIC CONDENSATION
      C*****************************************************************
            SN=0
      6     SN=SN+1
            IF(NOPT.EQ.1) CALL SFRAME(NB,NS,LC,SN,S,NOPRT,NRFJ,NBB)
      IF(NOPT.EQ.2) CALL CFRMIC(MB,NS,LC,SN,3,NOPRT)
      IF(NULC.EQ.1) GO TO 13
      CALL FRMASS(M,SN,LC,NB,NOPRT)
   13 CONTINUE
      CALL CONDEN(NB,NS,SN,S,&99)
      IF(SN.LT.NS) GOTO 6
      NB2N=(2*NB+2)*2
      DO 5 I=1,NS
      DO 5 J=1,NS
    5 S(I,J)=S(I+NB2N,J+NB2N)
C*****************************************************************
C  SUPERIMPOSE PLANE FRAME STIFFNESS MATRICES
C*****************************************************************
      IF(FRN.EQ.1) GOTO 7
      DO 8 I=1,NS
      DO 8 J=1,NS
      TEMP=ST(I,J)
    6 S(I,J)=S(I,J)+TEMP
    7 CONTINUE
      DO 9 I=1,NS
      DO 9 J=1,NS
    9 ST(I,J)=S(I,J)
      IF(FRN.LT.NFRMS) GOTO 2
      GO TO 100
   99 WRITE(6,700)
  700 FORMAT('1STIFFNESS MATRIX CONDENSATION ERROR. EXECUTION TERMINATED
     &.')
      RETURN 6
  100 RETURN
      END
```

GPRT.S STRUCT

```
MASSELM,N-T.TPFS.STRUCT
      SUBROUTINE STRUCT(NMOD,NS,LC,TWB,TLB,PHR,NOPRT,B,M,S,E,C,D)
C
C  THIS SUBROUTINE READS DATA DESCRIBING THE STRUCTURAL PROPERTIES OF A
C  BUILDING AND THE MODELING OPTION TO BE USED.
C  THREE OPTIONS ARE AVAILABLE:
C
C     NMOD = 1: DETAILED STRUCTURAL MODEL - ALL STRUCTURAL
C               ELEMENTS MUST BE SPECIFIED INCLUDING BEAMS,
C               COLUMNS, BRACING, STRUCTURAL WALLS, FLOOR WEIGHTS, ETC.
C
C     NMOD = 2: STORY STIFFNESS MODEL - ESTIMATED STORY
C               STIFFNESSES ARE SPECIFIED ALONG WITH FLOOR
C               WEIGHTS
C
C     NMOD = 3: EMPERICAL MODAL - THE FUNDAMENTAL PERIOD
C               OF THE BUILDING IS SPECIFIED AND A STRAIGHT-LINE
C               MODE SHAPE IS ASSUMED.
C
C  FOR NMOD = 1&2, AN NS X NS EIGENPROBLEM IS SOLVED WHERE NS EQUALS
C  THE NUMBER OF STORIES OF THE BUILDING.
C
       REAL M(30),C(73),D(70,70),LC(30),S(70,70),A(100),B(100),
      &PP(100),MT(30),E(30,30)
       WRITE(6,700)
   700 FORMAT(1H1,20X,'S T R U C T U R A L   A N A L Y S I S',///)
       READ (5,9000) NS,TWB,TLB,PHR,NOPRT
       WRITE(6,610) NS,TWB,TLB,PHR
   610 FORMAT('0NUMBER OF STORIES = ',I5,/,
     &        '0TOTAL BUILDING WIDTH (INCHES) = ',F7.1,/,
     &        '0TOTAL BUILDING LENGTH (INCHES) = ',F7.1,/,
     &        '0HEIGHT OF PARAPET (INCHES)     = ',F7.1,/)
  9000 FORMAT ( )
       IF (NMOD.NE.3) GO TO 10
       CALL STIFF3 (NS,LC,T1,C,D)
       GO TO 150
    10 IF (NMOD.NE.2) GO TO 20
       CALL STIFF2 (NS,S,LC)
       GO TO 30
    20 IF (NMOD.NE.1) GO TO 40
       CALL STIFF1 (NOPT,NS,LC,S,M,$99,NOPRT)
    30 DO 25 I=1,NS
       DO 25 J=1,NS
    25 E(I,J)=S(I,J)
       WRITE(6,603)
   603 FORMAT('1STIFFNESS MATRIX (KIPS/IN)',/)
       CALL MATPRT(NS,NS,S)
       CALL FLMASS (NS,M)
       DO 60 I=1,NS
    60 C(I)=M(I)*386.4
       WRITE(6,604)
   604 FORMAT('1TOTAL WEIGHT VECTOR (KIPS)',/)
       CALL MATPRT(NS,1,C)
       CALL EIGENS (S,MT,M,C,D,NS,A,B,PP)
      DO 35 I=1,NS
      DO 35 J=1,NS
   35 S(I,J)=E(I,J)
      GO TO 50
  150 CONTINUE
      CALL FLMASS(NS,M)
      WRITE(6,609)
      DO 151 I=1,NS
  151 A(I)=M(I)*386.4
      CALL MATPRT(NS,1,A)
      GO TO 50
   40 WRITE (6,600)
  600 FORMAT ('1STRUCTURAL MODELING OPTION IMPROPERLY SPECIFIED.
     &          EXECUTION TERMINATED.')
   99 RETURN 8
   50 RETURN
      END

@PRT,S  DYNAMIC
```

```
WASSELM,N-T.TPFS.DYNAMC
      SUBROUTINE DYNAMC(N,LC,S,C,D,M,ASR,VSR,T,F,E,LD,NOPRT,
     6NMOD)
C
C
C  THIS SUBROUTINE COMPUTES THE DYNAMIC RESPONSE OF A BUILDING
C  TO A SEISMIC LOAD ENVIRONMENT CHARACTERIZED BY THE GROUND
C  SITE RESPONSE SPECTRUM. AN INITIAL VALUE OF STRUCTURAL DAMPING
C  IS COMPUTED, AND SUBSEQUENTLY UPDATED BY SUBROUTINE DAMPR
C  IN AN ITERATIVE MANNER UNTIL THE AMOUNT OF DAMPING IS CONSISTENT
C  WITH THE AMPLITUDE OF MOTION FOR THE TYPE OF STRUCTURE SPECIFIED.
C
      REAL T(100),F(100),C(70),D(70,70),S(70,70),DEFLY(30),DMU(30),
     6     M(30),W(30),V(30),E(30,30),MR,EE(30,24)/720*0.0/,DRFTY(30),
     6     LC(30),DISP(30)
      WRITE(6,700)
  700 FORMAT(1H1,20X,'E A R T H Q U A K E   R E S P O N S E   A N A L Y
     6S I S',///)
C
C  READ CONTL. VARS., STORY DRIFT TO YIELD, AND COMPUTE MODAL PARAMETERS.
C
      READ(5,9000) NDAMP,ITERAX,LD,MCOP
 9000 FORMAT( )
      WRITE(6,607) NDAMP,ITERMX,LD
      WRITE(6,610) MCOP
  610 FORMAT('0MODAL COMBINATION OPTION = ',I5)
  607 FORMAT('0DAMPING CURVE OPTION =',I5,/,
     6'0MAXIMUM NUMBER ITERATIONS =',I5,/,
     6'0MODIFY RESPONSE FOR DUCTILITY =',I5)
      EBETA=.05
      EEMU=.05
      READ(5,9000) (DRFTY(I),I=1,N)
      WRITE(6,650) (DRFTY(I),I=1,N)
  650 FORMAT('0EFFECTIVE INTERSTORY DRIFT TO YIELD BY STORY (IN/IN)',//,
     63(1X,1P10E10.2,/))
      EMU=1.0
      CALL DAMPR(NDAMP,EMU,BETA)
      WRITE (6,636) BETA
      NR=3
      N9=N
      IF(N.GT.6) N9=6
      IF(NMOD.EQ.3) N9=1
      ITER=0
   20 CONTINUE
      WRITE(6,600)
      TM=0.0
      ITER=ITER+1
      DO 8 I=1,N
    8 TM=TM+M(I)
      DO 2 I=1,N9
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      DO 1 J=1,N
      SUM2=SUM2+D(J,I)**2*M(J)
    1 SUM3=SUM3+D(J,I)*M(J)
      SUM1=SUM3**2
      A(I)=SUM1/SUM2
      TI=6.2831853/SQRT(C(I))
      CALL SPECTR(TI,EMU,T,F,BETA,ASK,VSR,SV,SVF,SVD,LU)
      C(I)=(6.283/TI)**2
      FI=1.0/TI
      V(I)=A(I)*2.0*3.1416*SVF/TI
      AR=SUM2/SUM3
      MR=M(I)/TM
      WRITE(6,601) I,FI,TI,MR,SV,V(I),AR,SVF,SVD
      X(I)=SVD*TI/6.283185/AR
    2 E(N,I)=SUM3
  606 FORMAT('0CRITICAL DAMPING (PERCENT) =',F8.2)
C
C  COMPUTE MODAL RESPONSE
C
      DO 7 I=1,N9
      DO 7 J=1,N
    7 E(J,I)=V(I)*D(J,I)*M(J)/C(N,I)
      DO 5 I=1,N9
      IF(NOPRT.NE.1) WRITE(6,602) I
      SUM1=0
      DO 3 J=1,N
      SUM1=SUM1+E(J,I)
      SUM2=D(J,I)*A(I)
      IF(J.EQ.N) SUM3=SUM2
      IF(J.NE.N) SUM3=SUM2-D(J+1,I)*A(I)
      SUM3=ABS(SUM3)
      IF(I.GT.6) GOTO 31
      II=I+6
      EE(J,II)=SUM3
      II=I+12
      EE(J,II)=SUM2*SQRT(C(I))
      II=I+18
      EE(J,II)=E(J,I)/M(J)/386.4
      IF (NOPRT.EQ.1) GO TO 3
   31 WRITE(6,603) J,E(J,I),SUM1,SUM2,SUM3,EE(J,I+12),EE(J,I+18)
    3 E(J,I)=SUM1
    5 CONTINUE
C
C  COMPUTE TOTAL RESPONSE
C
      GO TO (110,120,130), NCOP
  110 DO 111 I=1,N
      EE(I,4)=EE(I,7)
      EE(I,5)=EE(I,13)
  111 EE(I,6)=EE(I,19)
      GO TO 140
  120 DO 121 I=1,N
      SUM1=0.
      SUM2=0.
      SUM3=0.
      DO 122 J=1,N9
      SUM1=SUM1+EE(I,J+6)**2
      SUM2=SUM2+EE(I,J+12)**2
  122 SUM3=SUM3+EE(I,J+18)**2
      EE(I,4)=SQRT(SUM1)
      EE(I,5)=SQRT(SUM2)
  121 EE(I,6)=SQRT(SUM3)
  130 DO 131 I=1,N
      SUM1=0.
      SUM2=0.
      SUM3=0.
      DO 132 J=1,N9
      SUM1=SUM1+ABS(EE(I,J+6))
      SUM2=SUM2+ABS(EE(I,J+12))
  132 SUM3=SUM3+ABS(EE(I,J+18))
      EE(I,4)=SUM1
      EE(I,5)=SUM2
  131 EE(I,6)=SUM3
  140 CONTINUE
      WRITE(6,199)
  199 FORMAT('0 STORY          I. S. DEFL            VELOCITY              AC
     &CELERATION',/,
     &'   NO.            (IN)                  (IN/SEC)                  (G)',/
     $)
      DO 200 I=1,N
  200 WRITE(6,665) I,EE(I,4),EE(I,5),EE(I,6)
  665 FORMAT(I4,1X,1P3E20.4)
C
C  COMPUTE DUCTILITY BY STORY AND EFFECTIVE DUCTILITY FOR BUILDING
C
      EMU1=EMU
      DO 150 I=1,N
  150 DMU(I)=EE(I,4)/LC(I)/DRFTY(I)
      WRITE(6,670) (DMU(I),I=1,N)
  670 FORMAT('0DUCTILITY BY STORY',//,3(1X,1P10E10.2,/))
      DISP(N)=EE(N,4)
      DEFLY(N)=DRFTY(N)*LC(N)
      DO 210 I=2,N
      II=N+1-I
      DISP(II)=DISP(II+1)+EE(II,4)
  210 DEFLY(II)=DEFLY(II+1)+DRFTY(II)*LC(II)
      IF(NMOD.EQ.3) GO TO 180
      DO 160 I=1,N
      V(I)=0.
      W(I)=0.
      DO 160 J=1,N
      V(I)=V(I)+S(I,J)*DISP(J)
  160 W(I)=W(I)+S(I,J)*DEFLY(J)
      SUM1=0.
      SUM2=0.
      DO 170 I=1,N
      SUM1=SUM1+DISP(I)*V(I)
  170 SUM2=SUM2+DEFLY(I)*W(I)
      EMU=SQRT(SUM1/SUM2)
      GO TO 190
  180 CONTINUE
      SUM1=0.
      DO 181 I=1,N
  181 SUM1=SUM1+DMU(I)
      EMU=SUM1/N
  190 WRITE(6,680) EMU
  680 FORMAT('0EFFECTIVE DUCTILITY FOR BUILDING = ',F6.2)
      IF(ITER.GE.ITERMX) GO TO 11
      BETA1=BETA
      CALL DAMPR(NDAMP,EMU,BETA)
      WRITE(6,606) BETA
C
C  TEST FOR CONVERGENCE OF DUCTILITY AND DAMPING
C
      IF(LD.EQ.0) GO TO 10
      IF(ABS(1.-EMU/EMU1).GT.EEMU) GO TO 20
   10 CONTINUE
      IF (ABS(1.0-BETA/BETA1).GT.EBETA) GO TO 20
   11 CONTINUE
C
C  PRINT FINAL RESPONSE CALCULATIONS.
C
      IF(NOPRT.EQ.1) GO TO 91
      DO 51 I=1,N
      IF(NOPT.EQ.3) GOTO 91
      SUM=0.0
      SUM1=0.0
      SUM2=0.0
      DO 4 J=1,N
      SUM2=SUM2+ABS(E(I,J))
      SUM1=SUM1+E(I,J)**2
    4 CONTINUE
      EE(I,2)=SQRT(SUM1)
      EE(I,3)=SUM2
   51 EE(I,1)=E(I,1)
      DO 30 K=1,NR
      WRITE(6,604) K
      DO 30 I=1,N
      IF (I.EQ.1) SUM1=EE(I,K)
      IF (I.GT.1) SUM1=EE(I,K)-EE(I-1,K)
   30 WRITE(6,605) I,SUM1,EE(I,K)
  600 FORMAT ('1',/,
     *'  MODE  FREQUENCY PERIOD  MASS  PSUDO-SPECTRAL   MAXIMUM',
     *'  AMPLITUDF      PS.SPECT.VEL. MODIFIED FOR DUCTILITY',/,
     *'   NO.    (CPS)   (SEC.)  RATIO   VELOCITY      BASE SHEAR',
     *'  RATIO       (ACCEL)      (DISPL)',/)
  601 FORMAT(I4,F12.4,2F7.3,F11.3,F15.3,F11.3,2F11.3)
  602 FORMAT ('1',/,
     *'    EFFECTIVE FORCE FOR MODE NO.',I4,//,
     *' STORY   FORCE(KIPS)   SHEAR(KIPS)   DEFLECTION   STORY DRIFT',
     &'  VELOCITY  ACCELERATION',/)
  603 FORMAT(I5,F12.3,F14.3,4F14.4)
  604 FORMAT ('1',/,
     *'   COMBINED FORCE FOR ALL MODES (METHOD',I5,')',/,/,
     *' STORY   FORCE(KIPS)   SHEAR(KIPS)',/)
 605 FORMAT(I5,F12.3,F14.3)
  91 CONTINUE
     DO 9 I=1,N
     DO 9 J=1,24
   9 E(I,J)=EE(I,J)
     RETURN
     END

@PRT,S  STAT,C
```

```
HASSELMAN-T*TPFS.STATIC
      SUBROUTINE STATIC(NNAZ,NS,S,LC,TAB,PHR,TI,DHFT,WT,
     &DN,VF,M,CEC,CIC,QMS,VMM,ISHAPE,ISITE,NMOD,ITOR,ITYPE)
C
C  THIS SUBROUTINE COMPUTES THE STATIC RESPONSE OF A BUILDING
C  TO WIND PRESSURE DISTRIBUTIONS.
C
      REAL S(70,70),LC(30),DHFT(30),DF(30),WF(30),M(30),DN(70,70)
      REAL CEC(10),CIC(10),QMS(30),VMM(30)
      INTEGER NNAZ(3)
      WRITE(6,700)
  700 FORMAT(1H1,20X,'W I N D   R E S P O N S E   A N A L Y S I S',
     &////)
      IF((ITOR.EQ.-1).AND.(NNAZ(2).NE.0)) GO TO 23
      IF(NMOD.EQ.3) GOTO 23
C
C  INVERT STIFFNESS MATRIX
C
      CALL DECOMP(NS,S,&99)
      CALL INVERS(NS,S)
   23 CONTINUE
      TM=0.
      DO 10 I=1,NS
   10 TM=TM+M(I)
C
C  COMPUTE PRESSURE FORCES FOR EACH STORY
C
      IF(ITOR.EQ.-1) GO TO 16
      CALL WIND(LC,NS,TAB,TM,TI,CEC,CIC,QMS,VMM,WF,ISHAPE,ISITE,VF,ITYPE
     &S)
      GO TO 17
   16 CONTINUE
      WRITE(6,750)
  750 FORMAT(1H0,20X,'W I N D   D U E   T O   T O R N A D O',///)
      CALL TRNADO(VT,LC,NS,WF,TAB,CEC,CIC,QMS,VMM)
  900 FORMAT(1P13E10.2)
   17 IF(NMOD.EQ.3) GOTO 24
      GOTO 25
C
C  COMPUTE WIND DEFLECTIONS FOR EMPERICAL MODEL
C
24    SUM1=0.0
      SUM2=0.0
      DO 26 I=1,NS
      SUM1=SUM1+M(I)*386.4
26    SUM2=SUM2+WF(I)
      DO 27 I=1,NS
27    DF(I)=DN(I,1)*(3.89*TI)**2*(SUM2/SUM1)
      GOTO 28
C
C  COMPUTE WIND DEFLECTIONS FOR OTHER MODELS
C
25    DO 34 I=1,NS
      TEMP=0.0
```

```
          DO 35 J=1,NS
   35     TEMP=TEMP+S(I,J)*WF(J)
   34     DF(I)=TEMP
   28     SUM2=0.0
   C
   C  COMPUTE STORY DRIFT AND SHEAR
   C
          WRITE(6,657)
   657    FORMAT('1WIND ANALYSIS',/,
        6        '0STORY  DEFLECTION  DRIFT   STORY SHEAR',/,
        6        '  NO.    (INCHES)  (IN/IN)    (KIPS)',/)
          DO 36 I=1,NS
          SUM2=SUM2+WF(I)
          IF(I.EQ.NS)GOTO 37
          DRFT(I)=ABS(DF(I)-DF(I+1))
          GOTO 38
   37     DRFT(NS)=ABS(DF(NS))
   38     DRFT(I)=DRFT(I)/LC(I)
          WRITE(6,658) I,DF(I),DRFT(I),SUM2
   658    FORMAT(I4,F12.3,F9.4,F11.2)
   36     CONTINUE
          RETURN
       99 WRITE(6,660)
      660 FORMAT('0STIFFNESS MATRIX IS SINGULAR')
          RETURN 1
          END


@PRT,S  DAMAG
```

```
HASSELMAN-T.TPFS.DAMAG
      SUBROUTINE DAMAG(NHAZ,EM,AR,VR,NS,A,V,EDEFL,LC,TI,DRFT,
     &CEC,CIC,QMS,VMH,ITOR,LSROPT,IFLY,IW)
C
C THIS SUBROUTINE COMPUTES THE PERCENT DAMAGE TO BUILDINGS
C DUE TO EARTHQUAKE AND WIND ENVIRONMENTS. DAMAGE CATEGORIES
C INCLUDE STRUCTURAL, NONSTRUCTURAL AND GLASS.
C
      REAL A(30),V(30),DMU(3),DRFT(30),DMUC(3)
      REAL DMUF(30,3),EDEFL(30),LC(30)
      INTEGER NHAZ(3)
      REAL HW(30),BW(30),Q(30),DC(30),DST(3),THG(30)
      REAL CEC(10),CIC(10),QMS(30),VMH(30),DGA(5)
      REAL DELTY(30,3),CVDY(30,3),CVDMUF(30,3),CVDLTG(30)
      REAL DELTYP(30),CVDYP(30),CVPZR(30)
  622 FORMAT ('0DRIFT TO YIELD BY STORY (FRAME)',//,
     & 3(1X,1P10E10.2,/))
  623 FORMAT ('0COEFFICIENT OF VARIATION BY STORY',//,
     & 3(1X,1P10E10.2,/))
  632 FORMAT ('0DRIFT TO YIELD BY STORY (WALL)',//,
     & 3(1X,1P10E10.2,/))
  642 FORMAT ('0DRIFT TO YIELD BY STORY (DIAPHRAGM)',//,
     & 3(1X,1P10E10.2,/))
  687 FORMAT ('0DRIFT TO YIELD BY STORY (PARTITIONS)',//,
     & 3(1X,1P10E10.2,/))
  600 FORMAT('0QUALITY FACTOR OF CONSTRUCTION BY STORY',//,
     & 3(1X,1P10E10.2,/))
  620 FORMAT('0DUCTILITY TO FAILURE BY STORY (FRAME)',//,
     & 3(1X,1P10E10.2,/))
  630 FORMAT('0DUCTILITY TO FAILURE BY STORY (WALL)',//,
     & 3(1X,1P10E10.2,/))
  690 FORMAT('0DUCTILITY TO FAILURE BY STORY (DIAPHRAGM)',//,
     & 3(1X,1P10E10.2,/))
  670 FORMAT('0MEAN BREAKING STRESS OF GLASS',//,1X,1P10E10.2)
 9000 FORMAT( )
  682 FORMAT('0HEIGHT OF WINDOWS BY STORY (INCHES)',//,3(1X,1P10E10.2,/)
     &)
  683 FORMAT('0WIDTH OF WINDOWS BY STORY (INCHES)',//,3(1X,1P10E10.2,/))
  684 FORMAT('0AVERAGE CLEARANCE IN MULLIONS (INCHES)',//,3(1X,1P10E10.2
     &,/))
  685 FORMAT('0THICKNESS OF WINDOW GLASS BY STORY (INCHES)',//,
     & 3(1X,1P10E10.2,/))
      WRITE(6,8000)
 8000 FORMAT(1H1,20X,'D A M A G E   A N A L Y S I S',///)
      IF(ITOR.EQ.-1) GO TO 41
C
C READ DAMAGEABILITY INPUTS FOR EQUAKE, WIND, OR TORNADO
C
      READ(5,9000) (DELTY(I,1),I=1,NS)
      WRITE(6,622) (DELTY(I,1),I=1,NS)
      READ(5,9000) (CVDY(I,1),I=1,NS)
      WRITE(6,623) (CVDY(I,1),I=1,NS)
      READ(5,9000) (DELTY(I,2),I=1,NS)
      WRITE(6,632) (DELTY(I,2),I=1,NS)
      READ(5,9000) (CVDY(I,2),I=1,NS)
      WRITE(6,623) (CVDY(I,2),I=1,NS)
      READ(5,9000) (DELTY(I,3),I=1,NS)
      WRITE(6,642) (DELTY(I,3),I=1,NS)
      READ(5,9000) (CVDY(I,3),I=1,NS)
      WRITE(6,623) (CVDY(I,3),I=1,NS)
      READ(5,9000) (HW(I),I=1,NS)
      WRITE(6,682) (HW(I),I=1,NS)
      READ(5,9000) (AW(I),I=1,NS)
      WRITE(6,683) (QW(I),I=1,NS)
      IF(NHAZ(I).EQ.0) GO TO 10
C
C  READ DAMAGEABILITY INPUTS FOR EQUAKE ONLY
C
      READ(5,9000)(DMUF(I,1),I=1,NS)
      WRITE(6,623)(DMUF(I,1),I=1,NS)
      READ(5,9000) (CVDMUF(I,1),I=1,NS)
      WRITE(6,623) (CVDMUF(I,1),I=1,NS)
      READ(5,9000)(DMUF(I,2),I=1,NS)
      WRITE(6,639)(DMUF(I,2),I=1,NS)
      READ(5,9000) (CVDMUF(I,2),I=1,NS)
      WRITE(6,623) (CVDMUF(I,2),I=1,NS)
      READ(5,9000)(DMUF(I,3),I=1,NS)
      WRITE(6,640)(DMUF(I,3),I=1,NS)
      READ(5,9000) (CVDMUF(I,3),I=1,NS)
      WRITE(6,623) (CVDMUF(I,3),I=1,NS)
      READ(5,9000) (Q(I),I=1,NS)
      WRITE(6,600) (Q(I),I=1,NS)
      READ(5,9000) (DC(I),I=1,NS)
      WRITE(6,684) (DC(I),I=1,NS)
      READ(5,9000) (CVDLTG(I),I=1,NS)
      WRITE(6,623) (CVDLTG(I),I=1,NS)
   10 CONTINUE
      IF((NHAZ(2).EQ.0).AND.(NHAZ(3).EQ.0)) GO TO 15
C
C  READ DAMAGEABILITY INPUTS FOR WIND OR TORNADO ONLY
C
      READ(5,9000) (DELTYP(I),I=1,NS)
      WRITE(6,687) (DELTYP(I),I=1,NS)
      READ(5,9000) (CVDYP(I),I=1,NS)
      WRITE(6,623) (CVDYP(I),I=1,NS)
      READ(5,9000) (THG(I),I=1,NS)
      WRITE(6,685) (THG(I),I=1,NS)
      READ(5,9000) SGB
      WRITE(6,670) SGB
      READ(5,9000) (CVPZR(I),I=1,NS)
      WRITE(6,623) (CVPZR(I),I=1,NS)
   15 CONTINUE
C
C  COMPUTE EARTHQUAKE DAMAGE FOR EACH FLOOR
C
      IF(NHAZ(1).EQ.0)GO TO 42
C
C  STRUCTURAL DAMAGE
```

```
C
      WRITE(6,699)
  699 FORMAT('ISTRUCTURAL DAMAGE DUE TO EARTHQUAKE (PERCENT)',//,
     & ' STORY                 FRAME            WALL               DIAPHRAGM',/,
     & '  NO.                  DAMAGE           DAMAGE             DAMAGE',///)
  700 FORMAT(I4,6X,5X,F10.2,5X,F10.2,5X,F10.2,4F10.2)
      DO 20 I=1,NS
      DO 30 J=1,3
      DMUC(J) = T1*DMUF(I,J)/.0096/(10.**(.434*EM))
      IF(DMUC(J).LT.1.0) DMUC(J)=1.0
      IF(DMUC(J).GT.DMUF(I,J)) DMUC(J)=DMUF(I,J)
      DMU(J)=EDEFL(I)/LC(I)/DELTY(I,J)
   31 X=(DMU(J)/DMUC(J)-1.)/CVDMUF(I,J)
      DST(J)=RNORM(X)*100.
   30 CONTINUE
      WRITE(6,700) I,DST(1),DST(2),DST(3)
   20 CONTINUE
   25 CONTINUE
C
C  NONSTRUCTURAL DAMAGE INCLUDING GLASS
C
      WRITE(6,709)
  709 FORMAT('ONONSTRUCTURAL DAMAGE DUE TO EARTHQUAKE (PERCENT)',//,
     & ' STORY   MMI         MMI         MMI      MULLION   NONSTR    GLASS
     &',/,
     & '  NO.    (A)         (V)         (A,V)      DRIFT    DAMAGE    DAMAGE
     &',///)
  710 FORMAT(I4,4X,F4.1,6X,F4.1,6X,F4.1,4X,1PE8.2,0P*F10.2)
      DO 40 I=1,NS
      AMMI = 3.5*ALOG10(A(I))+10.28
      BMMI = 2.73*ALOG10(V(I))+5.16
      EMMI = AMAX1(AMMI , BMMI)
      X = -4.62 + .552*EMMI*(1.-(Q(I)-3.)/6.)
      DNST = 10.**X
      IF(DNST.GT.100.) DNST=100.
      DRFTG = 2.*DC(I)/HW(I)*(1.+HW(I)/BW(I))
      Y=EDEFL(I)/LC(I)
      X = (Y/DRFTG - 1.)/CVDLTG(I)
      DG = RNORM(X)*100.
      WRITE (6,710)I,AMMI,BMMI,EMMI,Y,DNST,DG
   40 CONTINUE
   42 CONTINUE
C
C  COMPUTE WIND DAMAGE FOR EACH FLOOR
C
      IF(NHAZ(2).EQ.3) GO TO 125
   41 CONTINUE
C
C  STRUCTURAL DAMAGE
C
      WRITE(6,719)
  719 FORMAT('ISTRUCTURAL DAMAGE DUE TO WIND (PERCENT)',//,
     & ' STORY                 FRAME            WALL               DIAPHRAGM',/,
     & '  NO.                  DAMAGE           DAMAGE             DAMAGE',///)
  720 FORMAT(I5,14X,F6.2,9X,F6.2,9X,F6.2)
      DO 100 I=1, NS
      DO 110 J=1,3
  111 X = (DRFT(I)/DELTY(I,J)-1.)/CVDY(I,J)
  113 DST(J) = 100.*RNORM(X)
  110 CONTINUE
      WRITE(6,720) I,DST(1),DST(2),DST(3)
  100 CONTINUE
C
C  NONSTRUCTURAL DAMAGE - PARTITIONS AND GLASS
C
      WRITE(6,729)
  729 FORMAT('1NONSTRUCTURAL DAMAGE DUE TO WIND (PERCENT)',//,
     & ' STORY               PARTITIONS     GLASS DAMAGE DUE TO DIRECT PR
     &ESSURE',/,
     & '  NO.                DAMAGE         WALL 1          WALL 2
     & WALL 3          WALL 4          CORNERS',//)
  730 FORMAT(I5,14X,F6.2,5(9X,F6.2))
  900 FORMAT(1P10E13.2)
      DO 120 I=1,NS
      X = (DRFT(I)/DELTYP(I)-1.)/CVDYP(I)
      DNST = 100.*RNORM(X)
      AA = AMIN1(HW(I),BW(I))
      BB = AMAX1(HW(I),BW(I))
      PZR = 568*THG(I)**2*(1.+1.61*(AA**3/BB**3))/.75/AA**2
      DO 119 J=1,5
      P=CEC(J)*QMS(I)-CIC(J)*VMH(I)
      P=ABS(P)/144.
      X=(P/PZR-1.)/CVPZR(I)
  119 DGA(J)=100.*RNORM(X)
      WRITE(6,730) I,DNST,(DGA(J),J=1,5)
  120 CONTINUE
  125 CONTINUE
      IF(LSPOPT.EQ.0) GO TO 500
C
C  LONG SPAN ROOF DAMAGE
C
      WRITE(6,800)
      IF(IFLT.NE.0)WRITE(6,810)
      IF(IW.NE.0) WRITE(6,820)
      IF((IFLY.EQ.0).AND.(IW.EQ.0)) WRITE(6,830)
  800 FORMAT('0DAMAGE TO LONG-SPAN ROOF',//)
  810 FORMAT(10X,'ROOF TIE-DOWN SUPPORTS ARE INADEQUATE TO RESIST ',/,
     &' NET UPLIFT PRESSURE DUE TO WIND. PREDICT ROOF SEPARATION.',/)
  820 FORMAT(10X,'ROOF DESIGN IS INADEQUATE TO SUPPORT DEAD WEIGHT',/,
     &10X,'DUE TO PONDING. PREDICT COLLAPSE.',/)
  830 FORMAT(10X,'TIE-DOWN CAPACITY AND DEAD WEIGHT CAPACITY ARE',/,
     &10X,'ADEQUATE TO RESIST PREDICTED LEVELS OF NET UPLIFT',/,
     &10X,'DUE TO WIND, AND COLLAPSE DUE TO PONDING (IF ANY).',/,
     &10X,'NO DAMAGE IS PREDICTED.')
  500 RETURN
      END
```

```
MASSELM,N-T.TPFS.SEISMC
          SUBROUTINE SEISMC(LRISK,DLAT,DLONG,EM,AR,VR,DR)
      C
      C  THIS SUBROUTINE READS SEISMICITY DATA OBTAINED FROM
      C  TABLES AND COMPUTES HARD ROCK ACCELERATION, VELOCITY AND
      C  DISPLACEMENT CHARACTERISTICS
      C
        610 FORMAT('0MEAN SEISMICITY      =',1PE10.3,5X,
           &'STANDARD DEVIATION =',1PE10.3)
        620 FORMAT('0PROBABILITY THAT EARTHQUAKE OF MAGNITUDE',F5.1,2X,/,
           &1X,'OR LARGER WILL NOT OCCUR DURING A PERIOD OF',F7.1,2X,
           &'YEARS =',F6.3)
        630 FORMAT('0SELECTED SEISMICITY:  MEAN PLUS',F5.1,2X,
           &'SIGMA =',F5.1)
       9000 FORMAT( )
            WRITE(6,700)
        700 FORMAT(1H1,20X,'E A R T H Q U A K E   L O A D   A N A L Y S I S',///
           &)
            IF(LRISK.NE.0) GO TO 10
            READ(5,9000) EM,RBAR
            GO TO 100
         10 CONTINUE
            READ(5,9000) LP
            IF(LP.NE.0) GO TO 20
            READ(5,9000) RNI
            RN=1./RNI
            GO TO 30
         20 CONTINUE
            READ(5,9000) BLIFE,PNOC
            RN=ALOG(1./PNOC)/BLIFE
         30 CONTINUE
            READ(5,9000) A,ASIG,RBAR
            WRITE(6,610) A,ASIG
            EM=(A-ALOG10(RN))/.9
            IF(LP.EQ.0) WRITE(6,621) EM,RNI
        621 FORMAT('0RETURN PERIOD FOR EARTHQUAKE OF MAGNITUDE',F6.2,
           &2X,' = ',F8.1,2X,'YEARS')
            IF(LP.NE.0) WRITE(6,620)EM,BLIFE,PNOC
            READ(5,9000) ENSIG,EMMAX
            A=A+ENSIG*ASIG
            WRITE(6,630) ENSIG,A
            EM=(A-ALOG10(RN))/.9
            IF(EM.GT.EMMAX) EM=EMMAX
        100 CONTINUE
      C
      C  COMPUTE HARD ROCK GROUND MOTION
      C
            READ(5,9000) LCOP
            IF(LCOP.EQ.0) GO TO 110
            WRITE(6,640)
        640 FORMAT('0USER INPUT CONSTANTS FOR COMPUTING HARD ROCK GROUND MOTIO
           &N',//)
            READ(5,9000) C1,C2,C3
            READ(5,9000) CA1,CA2

@PRT,S SEISMC
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```
      READ(5,9000) CD1,CD2
      WRITE(6,650) C1,C2,C3,CA1,CA2,CD1,CD2
  650 FORMAT(1X,1P10E10.2)
      GO TO 120
  110 CONTINUE
      IF(DLONG.GT.105.)GO TO 115
      C1=.00867
      C2=.563
      C3=.979
      GO TO 116
  115 C1=.0237
      C2=.563
      C3=1.403
  116 CONTINUE
      CA1=-1.5675
      CA2=0.7718
      CD1=-0.6194
      CD2=1.1438
  120 VR=C1*10.**(C2*EM)*RBAR**(-C3)
      AA=CA1+CA2*ALOG10(VR)
      DD=CD1+CD2*ALOG10(VR)
      AR=10.**AA
      DR=10.**DD
      WRITE(6,660) EM,RBAR,AR,VR,DR
  660 FORMAT('0HARD ROCK GROUND MOTION CHARACTERISTICS',//,
     610X,'RICHTER MAGNITUDE              =',1PE10.2,/,
     610X,'HYPOCENTRAL DISTANCE (MILES) =',1PE10.2,/,
     610X,'HARD ROCK ACCELERATION (G)    =',1PE10.2,/,
     610X,'HARD ROCK VELOCITY (IN/SEC)   =',1PE10.2,/,
     610X,'HARD ROCK DISPLACEMENT (IN)   =',1PE10.2)
      RETURN
      END

@PRT,S  SDYN
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```
MASSELM,N-T.TPFS.SDYN
      SUBROUTINE SDYN(AMP,SIG)
C     AMSREM      NOV 67
C  COMPUTES AND PLOTS AMPLIFICATION SPECTRA FOR LAYERED SITES
C    USES HYSTERESIS MODEL  WITH CONSTANT PHASE ANGLE  PHI
      DIMENSION EJ(4,4),EP(4,4),Y(4),Z(2,3),AMPRAT(2)
C   DIMENSIONED FOR 20 LAYERS PLUS BEDROCK  TO INCREASE THE MAXIMUM
C   NUMBER OF LAYERS, CHANGE THE FOLLOWING DIMENSION CARDS
      DIMENSION THICK(21),DENSI(21),VELOC(21),PHI(21),
     1 RHO(21),PCPE(21),PCIM(21),APFREQ(21),APPAMP(21)
      REAL AMP(100)
C  SET CONSTANTS
      KOUNT=0
      PI = 3.1415926
      THETO = 1.0E+30
      STEP=0.1
      START=0.1
      IRANGE=100
C     INPUT THE TYPE OF ANALYSIS ** DYNAMIC OR PSUDEO DYNAMIC **
C     AND THE NUMBER OF LAYERS ** MAXIMUM NUMBER IS 20
      READ(5,1) ITYPE,M
    1 FORMAT( )
C  INPUT THE THICKNESS, UNIT WEIGHT, VELOCITY, AND PHASE ANGLE OF EACH LAYER
C  CARDS MUST BE IN ASCENDING ORDER WITH BEDROCK FIRST AND THE TOP LAYER LAST
      TI=0.0
      HI=0.0
      VAV=0.0
      WAV=0.0
      M = M+1
      IF (ITYPE.EQ.1) GO TO 2
      CALL EDYN(VELOC,THICK,DENSI,PHI,M,0,APFREQ)
      GO TO 3
    2 DO 10 K=2,M
      READ (5,1) THICK(K),DENSI(K),VELOC(K),PHI(K)
   10 CONTINUE
      VELOC(1)=8000.
      DENSI(1)=150.
      THICK(1)=0.0
      PHI(1)=0.0
    3 DO 11 I=1,M
   11 RHO(I)=DENSI(I)/32.2
      K=M
      DO 2001 II=1,M
      HI=HI+THICK(K)
      TI=TI+(THICK(K)/VELOC(K))
      VAV=VAV+THICK(K)*VELOC(K)
      WAV=WAV+THICK(K)*DENSI(K)
      IF(HI.LE.100.0) TVAV=VAV
      IF(HI.LE.100.0) TWAV=WAV
 2001 K=K-1
C  COMPUTE THE APPROXIMATE FREQUENCY AND AMPLIFICATION OF EACH LAYER
      APFREQ(1) =  0.0
      APPAMP(1) =  0.0
      DO 15 I  = 2,M
      APFREQ(I)  = VELOC(I) /(4.0*THICK(I))
   15 APPAMP(I) = DENSI(I-1)/DENSI(I)*VELOC(I-1)/VELOC(I)
      TI=4.0*TI
C      COMPUT DAF AVERAGE AFTER WIGGINS
      R=SQRT((8000.0*158.0)/((TWAV/100.0)*(TWAV/100.0)))
   20 WRITE (6,1006)
 1006 FORMAT (1H0,5HLAYER,2X,9HTHICKNESS,7X,7HDENSITY,6X, 8HVELOCITY,6X,
     17HDAMPING)
      DO 21  K = 1,M
      I  = M+1- K
   21 WRITE (6,1007) I, THICK(I), DENSI(I), VELOC(I), PHI(I)
 1007 FORMAT (I4,F11.1,2F15.1,F15.3)
      DO 5 I=1,M
      PHI(I)=PHI(I)*2.0
    5 CONTINUE
      P = START
      F = 1.0/P
C              START OF MAIN LOOP OF COMPUTATIONS
   70 DO 900 II = 1,IRANGE
      W = 2.0*PI*F
      DO 300 K=1,2
      DO 80  I  = 1,4
      DO 80  J  = 1,4
   80 XP(J,I) = 0.0
      DO 90 I = 1,4
   90 XP(I,I) = 1.0
C   CALCULATION OF REAL AND IMAGINARY PARTS OF PROPAGATION CONSTANT
      GO TO (91,95),K
   91 DO 94 L=1,M
      PCRE(L) = W/VELOC(L)
   94 PCIM(L) = 0.0
      GO TO 100
   95 DO 99 L = 1,M
      PCIM(L) = -PCRE(L)*PHI(L)/2.0
   99 CONTINUE
C                    START OF RECURSION RELATION LOOP
C   CALCULATION OF REAL AND IMAGINARY PARTS OF THE ALPHAS
  100 DO 200 J = 1,N
      ALFCON = (RHO(J)/RHO(J+1))/(PCRE(J) + PCIM(J)*(PCIM(J)/PCRE(J)))
      ALFRE  = ALFCON*(PCRE(J+1) + PCIM(J+1)*(PCIM(J)/PCRE(J)))
      ALFIM  = ALFCON*(PCIM(J+1) - PCRE(J+1)*(PCIM(J)/PCRE(J)))
      ALFREP = 1.0 + ALFRE
      ALFREM = 1.0 - ALFRE
      THETA = PCRE(J+1)*THICK(J+1)
      IF (THETA .GT. THETO) GO TO 200
      SINJ = SIN(THETA)
      COSJ = COS(THETA)
      OMEGA = PCIM(J+1)*THICK(J+1)
  110 EXPOM = 0.5*EXP( OMEGA)
      EXPOP = 0.5*EXP(-OMEGA)
C  CALCULATION OF  XJ  MATRIX
      XJ(1,1) = EXPOM * (ALFREP*COSJ + ALFIM*SINJ)
      XJ(1,2) = EXPOM * (ALFREM*COSJ - ALFIM*SINJ)
      XJ(1,3) = EXPOM * (ALFREP*SINJ - ALFIM*COSJ)
      XJ(1,4) = EXPON * (ALFREM*SINJ + ALFIM*COSJ)
      XJ(2,1) = EXPOP * (ALFREM*COSJ + ALFIM*SINJ)
      XJ(2,2) = EXPOP * (ALFREP*COSJ - ALFIM*SINJ)
      XJ(2,3) = -EXPOP *(ALFREM*SINJ - ALFIM*COSJ)
      XJ(2,4) = -EXPOP *(ALFREP*SINJ + ALFIM*COSJ)
      XJ(3,1) = -XJ(1,3)
      XJ(3,2) = -XJ(1,4)
      XJ(3,3) =  XJ(1,1)
      XJ(3,4) =  XJ(1,2)
      XJ(4,1) = -XJ(2,3)
      XJ(4,2) = -XJ(2,4)
      XJ(4,3) =  XJ(2,1)
      XJ(4,4) =  XJ(2,2)
C  CALCULATION OF  XP  MATRIX
      DO 130  J1 = 1,4
      DO 120  J2 = 1,4
      Y(J2) = 0.0
      DO 120  J3 = 1,4
  120 Y(J2) = Y(J2) + XJ(J2,J3)*XP(J3,J1)
      DO 130  J2 = 1,4
  130 XP(J2,J1) = Y(J2)
  200 CONTINUE
C   CALCULATION OF AMPLIFICATION RATIO
      Z(1,1) = XP(2,2) - XP(1,2)
      Z(1,2) = XP(2,4) - XP(1,4)
      Z(1,3) = XP(1,1) - XP(2,1)
      Z(2,1) = XP(4,2) - XP(3,2)
      Z(2,2) = XP(4,4) - XP(3,4)
      Z(2,3) = XP(3,1) - XP(4,1)
      DEN = Z(1,1)*Z(2,2) - Z(1,2)*Z(2,1)
      DRN = Z(1,3)*Z(2,2) - Z(1,2)*Z(2,3)
      DIN = Z(1,1)*Z(2,3) - Z(2,1)*Z(1,3)
      DRO = DRN/DEN
      DIO = DIN/DEN
      CRN = XP(1,1) + XP(1,2)*DRO + XP(1,4)*DIO
      CIN = XP(3,1) + XP(3,2)*DRO + XP(3,4)*DIO
  300 AMPRAT(K) = SQRT(CRN*CRN + CIN*CIN)
      KOUNT=KOUNT+1
      IF(P.LE.1.000000 ) GO TO 3300
      AMPRAT(1)=R
      AMPRAT(2)=R
 3300 AMP(KOUNT)=AMPRAT(2)
      P = P + STEP
      F = 1.0/P
  900  CONTINUE
      DO 901 I=1,IRANGE
  901 AMP(I)=AMP(I)*(1.+SIG*.441)
      RETURN
      END

@PRT,S   EOYN
```

```
HASSELM,N-T.TPFS.EDYN
          SUBROUTINE EDYN(VI,TI,DEI,DAI,N,ITEST,W)
          REAL V(21),T(21),DE(21),DA(21),W(21),VI(21),TI(21),DEI(21),
         1DAI(21),EOP(21)
C
C          READ DATA IN DECENDING ORDER
C
          DAMP=1.0
          IF(ITEST.NE.1) READ(5,2) DAMP
          DO 1 I=1,N
          READ(5,2) T(I),DE(I),W(I)
        2 FORMAT( )
        1 CONTINUE
C
C         FORM OVERBURDEN PRESSURE WITH DEPTH
C
          SUM=0.0
          DO 4 I=1,N
          IF(W(I).GT.48.5) W(I)=48.5
          W(I)=W(I)/100.
          SUM=SUM+DE(I)*T(I)
          EOP(I)=SUM
        4 CONTINUE
          DO 5 I=1,N
          V(I)=27.9*((EOP(I)/(1.+W(I)))**.411)
        5 CONTINUE
          C1=DAMP*V(1)
          DO 10 I=1,N
       10 DA(I)=C1/V(I)
          VI(1)=8000.
          DEI(1)=158.
          DAI(1)=0.0
          TI(1)=0.0
C
C          CONVERT DATA TO ASCENDING ORDER
C
          M=N+1
          DO 6 I=2,M
          J=N-I+2
          VI(I)=V(J)
          TI(I)=T(J)
          DEI(I)=DE(J)
          DAI(I)=DA(J)
        6 CONTINUE
        7 CONTINUE
          RETURN
          END


@PRT,S SSTATA
```

```
MASSELM,M-T.TPFS.SSTATA
      SUBROUTINE SSTATA(AMP,SIG)
      REAL AMP(100),V(21),DE(21),T(21),DA(21)
      REAL W(21)
      READ(5,1) IAPRO,N
    1 FORMAT( )
      IF (IAPRO.EQ.1) GO TO 2
      IF(IAPRO.EQ.2) GO TO 10
      DO 3 I=1,N
      READ(5,1) V(I),DE(I)
    3 CONTINUE
      WRITE(6,50)
   50 FORMAT('1',10X,'DATA USED FOR DAF CALCULATIONS',//,15X,'VELOCITY',
     115X,'DENSITY',/)
      DO 51 I=1,N
      WRITE(6,52) V(I),DE(I)
   52 FORMAT(15X,F7.1,15X,F7.1)
   51 CONTINUE
      I1=1
      I2=N
      GO TO 5
C
C     CALCULATE A VELOCITY PROFILE FROM SOIL PROPERTIES
C
    2 CALL EDYN(V,T,DE,DA,N,1,W)
      WRITE(6,40)
   40 FORMAT('1',10X,'DATA USED FOR DAF CALCULATIONS',//,
     115X,'DENSITY',15X,'THICKNESS',15X,'WATER CONTENT',/)
      NN=N+1
      DO 41 I=2,NN
      J=N+2-I
      WRITE(6,42) DE(I),T(I),W(J)
   42 FORMAT(15X,F7.1,15X,F9.1,21X,F7.3)
   41 CONTINUE
      I1=2
      I2=NN
    5 CONTINUE
      SUM1=0.0
      SUM2=0.0
      DO 6 I=I1,I2
      SUM1=SUM1+V(I)
    6 SUM2=SUM2+DE(I)
      SUM1=SUM1/N
      SUM2=SUM2/N
      DAF2=8000.*150./(SUM1*SUM2)
      DAF=SQRT(DAF2)
      GO TO 15
C
C     CALCULATE DAF AFTER THAT RUSSIAN DUDE
C
   10 READ(5,1) ISOIL,H2O
      GO TO (31,32,33,34,35,36),ISOIL
   31 A=5.3
      GO TO 16
   32 A=2.8
      GO TO 16
   33 A=2.5
      GO TO 16
   34 A=2.0
      GO TO 16
   35 A=1.3
      GO TO 16
   36 A=1.0
   16 C1=EXP(-.0037*H2O*H2O)
      WRITE(6,54) H2O,ISOIL
   54 FORMAT('1',15X,'DEPTH TO WATER TABLE = ',F7.2,/,
     1             16X,'SOIL CODE. . . . . . = ',I7)
      DAF=A*(10.**(.301*C1))
   15 DAF=DAF*(1.+SIG*.441)
      DO 7 I=1,100
    7 AMP(I)=DAF
      RETURN
      END

@PRT,S  SSTATB
```

```
HASSELMAN-T.TPFS.SSTATB
      SUBROUTINE SSTATB(AMP,SIG)
      REAL AMP(100)
      READ(5,100) ICODE,ISAT
  100 FORMAT( )
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20),ICODE
    1 A=.011
      GO TO 101
    2 A= 2.5
      GO TO 101
    3 A=1.
      GO TO 101
    4 A=16.
      GO TO 101
    5 A=26.
      GO TO 101
    6 A=35.
      GO TO 101
    7 A=43.
      GO TO 101
    8 A=93.
      GO TO 101
    9 A=152.
      GO TO 101
   10 A=175.
      GO TO 101
   11 A=192.
      GO TO 101
   12 A=220.
      GO TO 101
   13 A=245.
      GO TO 101
   14 A=284.
      GO TO 101
   15 A=335.
      GO TO 101
   16 A=390.
      GO TO 101
   17 A=415.
      GO TO 101
   18 A=440.
      GO TO 101
   19 A=490.
      GO TO 101
   20 A=515.
  101 CONTINUE
      A=A*1000000.
      READ(5,100) M,DEN
      IF(M.GT.200.) GO TO 110
      IF (M.LT.30.) GO TO 111
      GO TO 112
  110 M=200.
      GO TO 112
  111 M=30.
  112 CONTINUE
      IF(DEN.LT.1) DEN=135.
      X=1./6.
      CO=(H*A)**X
      VS=125.3*CO/3.3
      IF(ISAT.EQ.1) VS=VS*.85
      WRITE(6,30) H,DEN,ICODE
   30 FORMAT('1',10X,'DATA USED FOR DAF CALCULATIONS',/,
     115X,'DEPTH...........= ',F7.1,' FT',/,
     215X,'DENSITY.........= ',F7.1,' PCF',/,
     315X,'GEOLOGIC CODE..= ',I7,//)
      DAF2=8000.*158./(VS*DEN)
      DAF=SQRT(DAF2)
      DAF=DAF*(1.+SIG*.491)
      DO 200 I=1,100
  200 AMP(I)=DAF
      RETURN
      END

@PRT,S  @IND
```

```
MASSELMAN-T.TPFS.WIND
      SUBROUTINE FIND(SH,NS,B,MASS,TN,CEC,CIC,WMS,VMH,FC,ISHAPE,ISITE,VF
     1,ITYPE)
      REAL MASS,SH(30),H(30),GUST(30),WMS(30),VMH(30),C(3)
      REAL FC(30),CEC(10),CIC(10)
      INTEGER ANGLE
      MASS=MASS*12000.
      DO 70 I=1,30
      H(I)=0.0
      GUST(I)=0.0
      WMS(I)=0.0
      VMH(I)=0.0
   70 CONTINUE
      B=B/12.
      READ(5,1) BS
    1 FORMAT( )
      FN=1./TN
      H(1)=SH(NS)/12.
      IF(NS.EQ.1) GO TO 9
      DO 19 I=2,NS
   19 H(I)=(SH(NS-I+1)/12.)+H(I-1)
    9 HT=H(NS)
      GO TO (2,3,4),ISITE
    2 ALFA=1./3.
      RK=.025
      ZG=1500.
      GO TO 5
    3 ALFA=1./4.5
      RK=.01
      ZG=1300.
      GO TO 5
    4 ALFA=1./7.
      RK=.005
      ZG=900.
    5 T=3600./VF
      IF(T.LT.30.) GO TO 6
      IF((T.LT.4300.).AND.(T.GE.30.)) GO TO 7
      IF(T.GE.4000.) GO TO 8
    6 F=1.56-0.0618*(ALOG10(T)**2)-0.0733*ALOG10(T)
      GO TO 16
    7 F=1.317+.06*(ALOG10(T/30.)**2)-0.277*ALOG10(T/30.)
      GO TO 16
    8 F=1.0
   16 VMS=(1.63*VF/F)*((30./ZG)**ALFA)
      VM30=VF/F
      W1=4.*B
      W2=4.*HT
      IF(W1.LT.W2) GO TO 20
      W3=W2
      GO TO 41
   20 W3=W1
   41 VH=VMS*1.46667*((HT/30.)**ALFA)/(ALFA+1.0)
      C(1)=3.85*FN*W3/VH
      C(2)=11.5*FN*B/VH
      C(3)=3.85*FN*HT/VH
      CSQ=1.0
      DO 15 I=1,3
   15 CSQ=CSQ*((1./C(I))-(1.-EXP(-2.*C(I)))/(2.*C(I)**2))
      XN=4000.*FN/VMS
      SP2=(XN**2)*(1.+XN**2)**(-4./3.)
      GO TO (21,22,23),ISITE
   21 SB=1.30-0.035*(ALOG10(HT/10.)**2)-0.205*ALOG10(HT/10.)
      GO TO 29
   22 IF(HT.LT.100.) GO TO 30
      IF(HT.GE.100.) GO TO 31
   30 SB=1.3-0.05*(ALOG10(HT/10.)**2)-.21*ALOG10(HT/10.)
      GO TO 29
   31 SB=1.04-.142*(ALOG10(HT/100.)**2)-.23*ALOG10(HT/100.)
      GO TO 29
   23 IF(HT.LT.100.) GO TO 32
      IF(HT.GE.100.) GO TO 33
   32 SB=1.3-.00746*(ALOG10(HT/10.)**2)-.277*ALOG10(HT/10.)
      GO TO 29
   33 SB=1.02-.161*(ALOG10(HT/100.)**2)-.252*ALOG10(HT/100.)
   29 S=SB/(1.0 + 0.002*B)
      AA=2.0*ALFA + 1.0
      PI=3.14
      IF(KP.GT.1) GO TO 88
      GO TO (86,87),ISHAPE
   86 CALL SHAPEX(CA,CB,ANGLE,ITYPE,0)
      GO TO 88
   87 READ(5,1) CA,CB,ANGLE
   88 DC=CA-CB
      PBAR=0.00256*(VMS**2)*B*(HT**AA)/(AA*(30.**(2.*ALFA)))*DC
      BA=PBAR/(2.*PI*FN*MASS*VH)
      R=((PI*CSQ*SP2)/(4.*(BA+BS)))+S
      R=SQRT(R)
      DO 35 I=1,NS
      TZ=2.35*SQRT(RK)/((H(I)/30.)**ALFA)
      GUST(I) = 1.0 +(5.1)*R*TZ
      VMH(I)=VMS*(H(I)/30.)**ALFA
      QMS(I)=0.00256*GUST(I)*(VMH(I)**2)
   35 CONTINUE
      B=B*12.
      CALL WNDFOR(QMS,SH,NS,B,CA,CB,ANGLE,FC,1)
      CALL INTPRS(QMS,GUST,VMH,CA,CB,CIC,CEC,ANGLE,ITYPE,NS,ISHAPE)
      RETURN
      END

@PRT,S  REG1
```

```
HASSELMAN-T.TPFS.REG1
            SUBROUTINE REG1(ALFA,BETA,DIFF)
            REAL VEL(10),RETRN(10)
            READ(5,2) NPTS
            WRITE(6,20) NPTS
         20 FORMAT('0',11X,'NUMBER OF DATA PTS FOR REGRESSION ANALYSIS',I5,//)
            READ(5,2)(VEL(I),I=1,NPTS,
            READ(5,2)(RETRN(I),I=1,NPTS)
          2 FORMAT( )
            WRITE(6,25) (VEL(I),I=1,NPTS)
         25 FORMAT('0',11X,'WIND VELOCITY (MPH)=',2X,10(F7.2,2X),/)
            WRITE(6,26) (RETRN(I),I=1,NPTS)
         26 FORMAT('0',11X,'RETURN PERIOD (YRS)=',2X,10(F7.2,2X),/)
            DO 3 I=1,NPTS
            RETRN(I)=1./RETRN(I)
          3 CONTINUE
            DO 8 I=1,NPTS
          8 RETRN(I)=ALOG10(RETRN(I))
      C
      C        DETERMINE THE COEFFICIENTS FOR THE 1ST ORDER LEAST SQUARES FIT
      C
            TEMP=0.0
            SUM=0.0
            DO 6 I=1,NPTS
            SUM=VEL(I)+ SUM
          6 TEMP=RETRN(I)+TEMP
            RMEAN=TEMP/FLOAT(NPTS)
            VMEAN=SUM/FLOAT(NPTS)
            DIFF=0.0
            DIF=0.0
            DO 7 I=1,NPTS
            DIFF=DIFF+(VEL(I)-VMEAN)**2
            DIF=DIF+(VEL(I)-VMEAN)*RETRN(I)
          7 CONTINUE
            BETA=DIF/DIFF
            ALFA=RMEAN-BETA*VMEAN
            DIFF=0.0
            DO 9 I=1,NPTS
            A=RETRN(I)-BETA*VEL(I)
            DIFF=DIFF+(A-ALFA)**2
          9 CONTINUE
            DIFF = SQRT(DIFF/FLOAT(NPTS-1))
            RETURN
            END

@PRT,S  SHAPEX
```

```
HASSELM,W-T.TPFS.SHAPEX
      SUBROUTINE SHAPEX(CA,CB,ANGLE,ITYPE,ICON)
      INTEGER ANGLE
      IF(ICON.NE.0) GO TO 500
      READ(5,501) ITYPE,ANGLE
  501 FORMAT( )
      WRITE(6,400)ITYPE,ANGLE
  400 FORMAT('0',11X,'BUILDING SHAPE CODE = ',I5,5X,'-WIND DIRECTION CODE
     1 = ',I5,/)
  500 CONTINUE
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23
     *,24,25),ITYPE
    1 GO TO (66,67,68),ANGLE
   66 CA=0.9
      CB=-0.3
      GO TO 200
   67 CA=0.5
      CB=-0.4
      GO TO 200
   68 CA=-0.4
      CB=CA
      GO TO 200
    2 GO TO (69,70,71),ANGLE
   69 CA=0.9
      CB=-0.5
      GO TO 200
   70 CA=0.5
      CB=-CA
      GO TO 200
   71 CA=-0.6
      CB=CA
      GO TO 200
    3 GO TO (72,70,73),ANGLE
   72 CA=0.9
      CB=-0.6
      GO TO 200
   73 CA=-0.7
      CB=CA
      GO TO 200
    4 GO TO (74,70,75),ANGLE
   74 CA=0.8
      CB=-0.5
      GO TO 200
   75 CA=-0.3
      CB=CA
      GO TO 200
    5 GO TO (69,76,77),ANGLE
   76 CA=0.6
      CB=-0.5
      GO TO 200
   77 CA=-0.5
      CB=CA
      GO TO 200
    6 GO TO (69,76,77),ANGLE
    7 GO TO (69,74,77),ANGLE
    8 GO TO (69,74,71),ANGLE
    9 GO TO (69,76,79),ANGLE
   78 CA=0.5
      CB=-0.6
      GO TO 200
   79 CA=-0.4
      CB=-0.3
      GO TO 200
   10 GO TO (69,80,68),ANGLE
   80 CA=0.5
      CB=-0.8
      GO TO 200
   11 GO TO (66,67,68),ANGLE
   12 GO TO (69,70,77),ANGLE
   13 GO TO (74,81,68),ANGLE
   81 CA=0.4
      CB=-0.5
      GO TO 200
   14 GO TO (66,90,77),ANGLE
   15 GO TO (82,81,73),ANGLE
   82 CA=.9
      CB=-.4
      GO TO 200
   16 GO TO (82,91,73),ANGLE
   17 GO TO (82,91,84),ANGLE
   84 CA=-.8
      CB=CA
      GO TO 200
   18 GO TO (82,91,84),ANGLE
   19 GO TO (85,91,71),ANGLE
   85 CA=-.4
      CB=-.2
      GO TO 200
   20 GO TO (66,81,71),ANGLE
   21 GO TO (66,86,71),ANGLE
   86 CA=.5
      CB=-.3
      GO TO 200
   22 GO TO (82,87,71),ANGLE
   87 CA=.5
      CB=-.4
      GO TO 200
   23 GO TO (88,81,73),ANGLE
   88 CA=.8
      CB=-.3
      GO TO 200
   24 GO TO (89,201,73),ANGLE
   89 CA=.8
      CB=-.6
      GO TO 200
   90 CA=0.4
      CB=-0.3
      GO TO 200
      91 CA=0.4
         CB=-CA
         GO TU 200
      25 GO TO (79,202,73),ANGLE
     201 WRITE(6,300)
     300 FORMAT('1    THERE IS NO A.N.S.I. CODE SPECIFICATION FOR A WIND DIR
        *ECTION EQUAL TO 45 DEGREES',/,'     ANALYSIS WILL THEREFORE BE BASE
        *D ON THE ASSUMPTION OF A ZERO (0) WIND ANGLE',///)
         ANGLE=1
         GO TO 89
     202 WRITE(6,300)
         ANGLE=1
         GO TO 79
     200 CONTINUE
         RETURN
         END

@PRT,S  WNDFOR
```

```
MASSELM,N-T.TPFS.WNDFOR
      SUBROUTINE WNDFOR(QMS,SH,NS,B,CA,CB,ANGLE,FC,IFL)
      REAL FC(30),QMS(30),SH(30)
      INTEGER ANGLE
      DO 1 I=1,NS
    1 FC(I)=QMS(I)
      DO 3 I=1,NS
      IJ=NS-I+1
    3 QMS(I)=FC(IJ)
      DO 4 I=1,30
      FC(I)=0.0
    4 CONTINUE
      FC(1)=B*SH(1)*(3.*QMS(1)+QMS(2))/8.
      DO 60 I=2,NS
      FC(I)=(3.*(SH(I)+SH(I-1))*QMS(I)+QMS(I-1)*SH(I-1)+QMS(I+1)*SH(I))*
     1B/8.
   60 CONTINUE
      SF=CA-CB
      DO 61 I=1,NS
   61 FC(I)=(CA-CB)*FC(I)/144000.
      IF(IFL.EQ.3) RETURN
      WRITE(6,70) CA,CB,SF
   70 FORMAT('1',9X,'EXTERNAL PRESSURE COEFFICIENT FOR WALL 1 . . .=',F8
     *     .3,/,10X,'EXTERNAL PRESSURE COEFFICIENT FOR WALL 2 . . .=',F
     *     8.3,/,10X,'SHAPE FACTOR FOR WIND DIRECTION . . .=',F8.3,/)
      GO TO (50,51,52),ANGLE
   50 ANGL= 0.0
      GO TO 55
   51 ANGL=45.0
      GO TO 55
   52 ANGL=90.0
   55 CONTINUE
      WRITE(6,71) ANGL
   71 FORMAT(10X,'WIND DIRECTION WITH RESPECT TO',/,
     *       10X,'NORMAL OF WALL 1 . . . . . . . . . . . . .=',F6.1,' DE
     *GREES',//)
      RETURN
      END

@PRT,S  INTPRS
```

```
HASSELMAN-T.TPFS.INTPRS
      SUBROUTINE INTPRS(Q,G,V,CA,CB,CIC,CEC,ANG,ITYPE,NS,ISHAPE)
      REAL Q(30),G(30),V(30),CIC(10),CEC(10)
      INTEGER ANG
C
C     INVERT THE ORDERING OF THE GUST FACTOR ARRAY
C
      IF(ISHAPE.EQ.1) GO TO 15
      READ(5,16) CC,CD
   16 FORMAT( )
      WRITE(6,501) CC,CD
  501 FORMAT('0',11X,'USER INPUT - PRESSURE COEFF;CIENTS = ',2X,2(F8.2,3
     2X),//)
   15 DO 1 I=1,NS
    1 V(I)=G(I)
      DO 2 I=1,NS
      J=NS-I+1
    2 G(I)=V(J)
C
C     COMPUT THE APPROACH PRESSURE WITHOUT GUST FACTOR
C     FOR INTERNAL PRESSURE CALCULATIONS
C
      DO 3 I=1,NS
    3 V(I)=Q(I)/G(I)
C
C     PRESSURE COEFFICIENT FOR BUILDING CORNERS PER ANSI A58.1-1972
C
      CK=-2.0
C
C     DETERMINE INTERNAL PRESSURE COEFFICIENT PER ANSI A58.1-1972
C
      READ(5,16) RATIO,IWALL
      WRITE(6,500) RATIO,IWALL
  500 FORMAT('0',11X,'OPEN AREA RATIO = ',F8.3,5X,'WALL CODE = ',I5,/)
      IF(RATIO.GT.0.3) GO TO 71
C
C     IWALL =1,4 CORRESPONDS TO THE  WALL NUMBERING CONVENTION
C     IWALL = 5 IS THE CODE FOR A UNIFORM DISTRIBUTION OF WINDOWS
C
      GO TO (62,63,64,65,91),IWALL
   62 GO TO (90,91,92),ANG
   63 GO TO (92,92,92),ANG
   64 GO TO (92,91,90),ANG
   65 GO TO (92,92,92),ANG
   90 CI=0.3 + (RATIO*5.)/3.
      GO TO 80
   91 CI=0.3
      GO TO 80
   92 CI=-0.3-RATIO
      GO TO 80
   71 GO TO (51,52,53,54,91),IWALL
   51 GO TO (93,94,95),ANG
   52 GO TO (95,95,95),ANG
   53 GO TO (95,94,93),ANG
   54 GO TO (95,95,93),ANG
   93 CI=0.4
      GO TO 80
   94 CI=0.4
      GO TO 80
   95 CI=-0.6
   80 CONTINUE
      IF(ISHAPE.EQ.2) GO TO 50
C
C     DETERMINE THE EXTERNAL PRESSUR COEFFICIENTS OF SIDE
C     WALLS PARALLEL TO GET LINE OF FRAME ACTION
C
      IF(ITYPE.LE.3) GO TO 10
      IF(ITYPE.GT.3.AND.ITYPE.LE.13) GO TO 11
      IF(ITYPE.GT.13.AND.ITYPE.LE.23) GO TO 12
      IF(ITYPE.EQ.24.OR.ITYPE.EQ.25) GO TO 13
   10 GO TO (20,21,22),ANG
   20 ANG=3
      GO TO 21
   22 ANG=1
      GO TO 21
   11 ITYPE=ITYPE+10
      GO TO (20,21,22),ANG
   12 ITYPE=ITYPE-10
      GO TO (20,21,22),ANG
   13 GO TO (23,23,24),ANG
   23 ANG=3
      GO TO 21
   24 ANG=1
   21 CALL SHAPEX(CC,CD,ANG,ITYPE,1)
   50 CONTINUE
C
C     DO A FREE BODY ANALYSIS OF EACH WALL FOR MAXIMUM WINDOW PRESSURE
C
      CEC(1)=CA
      CEC(2)=CB
      CEC(3)=CC
      CEC(4)=CD
      CEC(5)=CK
      DO 67 I=1,5
   67 CIC(I)=CI
      IF(IWALL.NE.5) GO TO 66
      C1=CA-CI
      C2=CB-CI
      C3=CC-CI
      C4=CD-CI
      C5=CK-CI
      IF(ABS(C1).GE.ABS(CA)) GO TO 90
      CIC(1)=-CI
   90 IF(ABS(C2).GE.ABS(CB)) GO TO 91
      CIC(2)=-CI
   91 IF(ABS(C3).GE.ABS(CC)) GO TO 92
      CIC(3)=-CI
   92 IF(ABS(C4).GE.ABS(CD)) GO TO 93
```

```
          CIC(4)=-CI
       93 IF(ABS(C5).GE.ABS(CK)) GO TO 66
          CIC(5)=-CI
       66 CONTINUE
C
C         AT THIS POINT ALL DATA IS READY FOR WINDOW PRESSURE CALCULATIONS
C
      900 FORMAT(1P10E10.2)
          RETURN
          END


@PRT,S  TRNADO


MASSELM,N-T*TPFS.TRNADO
          SUBROUTINE TRNADO(VT,SH,NS,FC,B,CE,CI,QMS,V)
          REAL CE(10),CI(10),V(30)
          REAL QMS(30),SH(30),FC(30)
C
C         CALCULATE A UNIFORM PRESSURE DISTRIBUTION - NO GUSTING
C         NO VARIATION WITH HEIGHT - ASSUME DIRECT HIT BY TORNADO
C
          DO 2 J=1,5
          CE(J)=1.0
        2 CI(J)=0.0
          DO 1 I=1,NS
          V(I)=0.0
        1 QMS(I)=0.00256*(VT**2)
          CALL WNDFOR(QMS,SH,NS,B,.9,-.3,1,FC,0)
       54 CONTINUE
          RETURN
          END


@PRT,S  PRSFLC


MASSELM,N-T*TPFS.PRSPEC
          SUBROUTINE PRSPEC(BASE,SIG)
          REAL BASE(100),PER(100)
          PER(1)=0.1
          DO 1 I=2,100
        1 PER(I)=PER(I-1)+0.1
          WRITE(6,100) SIG
      100 FORMAT('1',15X,'BASE SPECTRUM IN TERMS OF THE MEAN AND ',
         *F5.2,' STANDARD DEVIATIONS',///)
          DO 200 I=1,10
          J=10*(I-1)
          WRITE(6,101)(PER(J+K),K=1,10)
      101 FORMAT(10X,'PERIOD (SEC)',10(2X,F7.2))
          WRITE(6,102)(BASE(J+K),K=1,10)
      102 FORMAT(10X,'PSV (IN/SEC)',10(2X,F7.2),//)
      200 CONTINUE
          RETURN
          END
```

```
@PRT,S LSROOF

HASSELM,N-T.TPFS.LSROOF
          SUBROUTINE LSROOF(ITYPE,L,W,H,P1,PI,IFLY,IW)
          INTEGER TYPEA
          REAL L,LPR,LCP,TAB(9),VECTOR(15)
          READ(5,112) TYPEA,ALPHA,VL,CL,DOP,NP
      112 FORMAT( )
          WRITE(6,305)
          IF(TYPEA.EQ.3) READ(5,112) (VECTOR(I),I=1,NP)
          IF(TYPEA.EQ.3) WRITE(6,319) (VECTOR(I),I=1,NP)
      319 FORMAT('0',10X,'ROOF PRESSURE COEFFICIENTS - USER INPUT = ',/,15X,
         110(5X,F8.2),/,)
      305 FORMAT('1',15X,'L O N G   S P A N   R O O F   A N A L Y S I S',//)
      306 FORMAT('0',10X,'ANALYSIS CODE . . . . .=',I5,/,
         1              11X,'SLOPE OF ROOF . . . . .=',F8.2,' DEGREES',/,
         2              11X,'ROOF UPLIFT CAPACITY   =',1PE11.3,' POUNDS',/,
         3              11X,'COLLAPSE CAPACITY . . .=',1PE11.3,' POUNDS',/,
         4              11X,'DEPTH OF PONDING  . . .=',0PF8.2,' FEET',/,
         5              11X,'ROOF UPLIFT LOAD.  .  .=',1PE11.3,' POUNDS',/,
         6              11X,'PONDING LOAD. . .   .=',1PE11.3,' POUNDS',//)
          L=L/12.
          RL=0.0
          W=W/12.
          H=H/12.
          PI=-PI
          IF(ALPHA.GE.85.0) WRITE(6,111)
      111 FORMAT(//,5X,'*****   SLOPE OF ROOF WAS TOO GREAT FOR ANALYSIS, AN
         1GLE HAS BEEN RESET TO 85 DEGREES    *****')
          IF(ALPHA.GE.85.0) ALPHA=84.9
          IF(TYPEA.EQ.3) GO TO 1300
          FACT1=L/W
          FACT2=W/H
          FACT3=H/W
          IF(FACT1.LT.0.9.OR.FACT1.GT.2.5) GO TO 500
          IF(FACT2.LT.0.67.OR.FACT2.GT.1.5) GO TO 500
          IF(TYPEA.EQ.2) GO TO 500
C   GENERAL SWISS ANALYSIS FOR ROOF STABILITY
          IF(ALPHA.GE.0.0.AND.ALPHA.LT.20.0) WCP=-1.0
          IF(ALPHA.GE.20.0.AND.ALPHA.LT.50.0) WCP=0.01*(5.*ALPHA-200.)
          IF(ALPHA.GE.50.0.AND.ALPHA.LE.85.0) WCP=ALPHA*0.01
          LCP=-0.7
          WPR=WCP*PI
          LPR=LCP*PI
          AREA=W/2.*L
          VF=(WPR*AREA)+2.*(PI*AREA)+(LPR*AREA)
C   CHECK FOR STABILITY OF ROOF
          IF((VF+VL).GE.0.) GO TO 75
          IFLY=1
          GO TO 1500
       75 IFLY=0
          GO TO 1500
      500 CONTINUE
C    GENERAL ANSI ANALYSIS FOR ROOF STABILITY
          IF(FACT3.LE.0.) GO TO 19
          IF(FACT3.GE.0.001.AND.FACT3.LT.0.3) GO TO 20
      IF(FACT3.GE.0.3.AND.FACT3.LT.0.5) GO TO 21
      IF(FACT3.GE.0.5.AND.FACT3.LT.1.5) GO TO 22
      IF(FACT3.GE.1.5) GO TO 23
   19 WCP=-1.0
      GO TO 35
   20 TAB(1)=0.01*ALPHA
      TAB(2)=0.20
      TAB(3)=0.25
      TAB(4)=0.30
      TAB(5)=0.35
      TAB(6)=0.40
      TAB(7)=0.45
      TAB(8)=0.50
      TAB(9)=0.01*ALPHA
      GO TO 40
   21 TAB(1)=-1.0
      TAB(2)=-0.75
      TAB(3)=-0.50
      TAB(4)=-0.20
      TAB(5)=0.05
      TAB(6)=0.30
      TAB(7)=0.45
      TAB(8)=0.50
      TAB(9)=0.01*ALPHA
      GO TO 40
   22 TAB(1)=-1.0
      TAB(2)=-1.0
      TAB(3)=-0.80
      TAB(4)=-0.55
      TAB(5)=-0.30
      TAB(6)=-0.75
      TAB(7)=0.20
      TAB(8)=0.45
      TAB(9)=0.01*ALPHA
      GO TO 40
   23 TAB(1)=-1.0
      TAB(2)=-1.0
      TAB(3)=-1.0
      TAB(4)=-0.90
      TAB(5)=-0.60
      TAB(6)=-0.35
      TAB(7)=-0.10
      TAB(8)=0.20
      TAB(9)=0.01*ALPHA
   40 IF(ALPHA.GE.(0.0).AND.ALPHA.LT.(10.)) GO TO 95
      IF(ALPHA.GE.(50.).AND.ALPHA.LT.(85.)) GO TO 96
      DO 1 I=1,8
    1 IF(ALPHA.GE.(10.+(I-1)*5.).AND.ALPHA.LT.(10.+(I*5.))) GO TO 99
   95 WCP=-1.0
      GO TO 35
   96 WCP=TAB(9)
      GO TO 35
   99 WCP=TAB(I+1)
   35 LCP=-0.7
```

```
      IF(ALPHA.LT.10.0) LCP=-1.0
      WPR=-CP*PI
      LPR=LCP*PI
      AREA=W/2.*L
      VF=(WPR*AREA)+2.*(PI*AREA)+(LPR*AREA)
C  CHECK FOR STABILITY OF THE ROOF
      IF((VF+VL).GE.0.) GO TO 65
      IFLY=1
      GO TO 1500
   65 IFLY=0
      GO TO 1500
 1500 CONTINUE
C   DETAILED SWISS ANALYSIS
      DO 2 J=1,9
      IF(ITYPE.NE.J) GO TO 2
      GO TO 201
    2 CONTINUE
      DO 910 J=14,19
      IF(ITYPE.NE.J) GO TO 910
      GO TO 201
  910 CONTINUE
      IF(ITYPE.EQ.10.OR.ITYPE.EQ.20) GO TO 203
      IF(ITYPE.EQ.11.OR.ITYPE.EQ.21) GO TO 204
      IF(ITYPE.EQ.12.OR.ITYPE.EQ.22) GO TO 205
      IF(ITYPE.EQ.13.OR.ITYPE.EQ.23) GO TO 206
      IF(ITYPE.EQ.24) GO TO 201
      IF(ITYPE.EQ.25) GO TO 201
  201 CONTINUE
C   STANDARD SYMMETRIC BUILDINGS
      AREA=(W/2.)*(L/2.)
      VF=PI*AREA*(VECTOR(1)+VECTOR(2)+VECTOR(3)+VECTOR(4))+AREA*4.*PI
      IF((VF+VL).GE.0.) GO TO 55
      IFLY=1
      GO TO 1500
   55 IFLY=0
      GO TO 1500
  203 CONTINUE
C   PEAKED ROOF BUILDING
      C1=COS(60.*3.1416/180.)
      C2=COS(30.*3.1416/180.)
      X1=W*(C1**2)
      X2=W*(C2**2)
      A1=X1*L/2.
      A2=X2*L/2.
      VF=PI*A1*(VECTOR(1)+VECTOR(2))+PI*A2*(VECTOR(3)+VECTOR(4))
     1 +(A1+A2)*PI*2.
      IF((VF+VL).GE.0.) GO TO 54
      IFLY=1
      GO TO 1500
   54 IFLY=0
      GO TO 1500
  204 CONTINUE
C   SAW-TOOTHED BUILDING
      C1=COS(60.*3.1416/180.)
      C2=COS(30.*3.1416/180.)
      X1=W/4.*(C1**2)
      X2=W/4.*(C2**2)
      A1=X1*L
      A2=X2*L
      VF=PI*A1*(VECTOR(1)+VECTOR(3)+VECTOR(5)+VECTOR(7))
     1 +PI*A2*(VECTOR(2)+VECTOR(4)+VECTOR(6)+VECTOR(8))
     2+PI*L*W
      IF((VF+VL).GE.3.) GO TO 53
      IFLY=1
      GO TO 1500
   53 IFLY=0
      GO TO 1500
  205 CONTINUE
C   FLAT-ROOFED BUILDINGS
      C1=(30.*3.1416/180.)
      A1=((W-2*.7*H*COS(C1))+W)*0.5*.7*H*COS(C1)
      A2=((L-2.*.7*H*COS(C1))+L)*0.5*.7*H*COS(C1)
      A3=(L*W-(A1+A2)*2.)/4.
      VF=PI*A1*(VECTOR(7)+VECTOR(8))+PI*A2*(VECTOR(5)+VECTOR(6))
     1 +PI*A3*(VECTOR(1)+VECTOR(2)+VECTOR(3)+VECTOR(4))+PI*L*W
      IF((VF+VL).GE.3.) GO TO 52
      IFLY=1
      GO TO 1500
   52 IFLY=0
      GO TO 1500
  206 CONTINUE
C   ROOF-VENTED BUILDINGS
      X1=(W-H)/2.
      X2=H/2.
      A1=L*X1
      A2=X2*(0.6*L)
      VF=PI*A1*(VECTOR(1)+VECTOR(6))+PI*A2*(VECTOR(3)+VECTOR(4))
     * +PI*2.*A1
      IF((VF+VL).GE.3.) GO TO 51
      IFLY=1
      GO TO 1500
   51 IFLY=0
 1500 IF(CL.LE.0.) GO TO 81
C  COLLAPSE ANALYSIS DUE TO PONDING
      PAREA=L*W
      RL=PAREA*62.40*DOP
      IF(RL.LT.CL) GJ TO 81
      IW=1
      GO TO 800
   81 IW=0
  800 CONTINUE
      WRITE(6,306) TYPEA,ALPHA,VL,CL,DOP,VF,RL
      L=L*12.
      W=W*12.
      H=H*12.
      RETURN
      END

@PRT,S WUDL00
```

```
@ASSELM,N-T.TPFS.WNDLOD
      SUBROUTINE WNDLOD(ISITE,ISHAPE,VF)
      READ(5,1) ISITE,ITEST,ITY,ISHAPE
      WRITE(6,20)
   20 FORMAT('1',10X,'W I N D  L O A D  A N A L Y S I S',//)
      WRITE(6,10)ISITE,ITEST,ITY,ISHAPE
   10 FORMAT('0',10X,'ISITE= ',I5,5X,'ITEST= ',I5,5X,'ITY= ',I6,5X,'ISHA
     1PE= ',I5,//)
      SIG=0.0
      IF(ITEST.EQ.1) READ(5,1) SIG
      IF(ITEST.EQ.1) WRITE(6,50) SIG
   50 FORMAT('0',10X,'ANALYSIS TO BE BASED ON A MEAN WIND VELOCITY AND '
     1,F5.1,' SIGMA',//)
    1 FORMAT( )
      GO TO(71,78),ITEST
   71 CALL REG1(A1,B1,DIFF)
      GO TO (73,74),ITY
   73 READ(5,1) PERIOD
      WRITE(6,11) PERIOD
   11 FORMAT('/',11X,'RETURN PERIOD IN YRS = ',F10.2,//)
      XX=1./PERIOD
      GO TO 75
   74 READ(5,1) BLIFE,PROB
      WRITE(6,21) BLIFE,PROB
   21 FORMAT('0',11X,'LIFE OF BUILDING IN YRS = ',F8.2,5X,'PROBABILITY O
     1F NON OCCURRENCE = ',F8.3,//)
      XX=ALOG(1./PROB)/BLIFE
   75 VF = (ALOG10(XX)-A1)*(1.+SIG*DIFF))/B1
      WRITE(6,51) VF
   51 FORMAT('0',10X,'FASTEST MILE WIND VELOCITY AT 30 FT - FREE FIELD',
     1                /,11X,' (NO GUST) FOR THE STATISTICAL PARAMETERS CHOSE
     2N = ',F8.2,' MPH',//)
      GO TO 72
   78 READ(5,1) VF
      WRITE(6,13) VF
   13 FORMAT('0',11X,'USERS VALUE OF WIND VELOCITY -FASTEST MILE AT 30 F
     1T ABOVE GROUND - FREE FIELD IN MPH =',F10.2,//)
   72 CONTINUE
      RETURN
      END

@PRT,S SOILOD
```

```
HASSELMAN-T*NBS.SOILOD
      SUBROUTINE SOILOD(AR,VR,DR,Y,T)
      REAL AMP(100),Y(100),HR(100),T(100),TIN(100),YIN(100)
      DO 110 I=1,100
      Y(I)=0.0
      HR(I)=0.0
      T(I)=0.0
      AMP(I)=0.0
  110 CONTINUE
      READ(5,20) IPROC,SIG
   20 FORMAT( )
      GO TO (1,1,2,3,4),IPROC
    1 CALL SDYN(AMP,SIG)
      GO TO 5
    2 CALL SSTATA(AMP,SIG)
      GO TO 5
    3 CALL SSTATB(AMP,SIG)
      GO TO 5
    4 READ(5,20) NDATA
      READ(5,20) (TIN(I),I=1,NDATA)
      READ(5,20) (YIN(I),I=1,NDATA)
      GO TO 6
    5 CONTINUE
      PI=2.*3.1415926
      TA=PI*VR/(AR*386.)
      TD=PI*DR/VR
    6 CONTINUE
C
C     FORM PERIOD ARRAY
C
      DO 10 I=1,100
   10 T(I)=0.1*I
      IF(IPROC.EQ.5) GO TO 15
C
C     FORM HARD ROCK SPECTRUM
C
      DO 11 I=1,100
      IF(T(I).LT.TA) HR(I)=(T(I)*AR*386./PI)
      IF (T(I).GE.TA.AND.T(I).LT.TD) HR(I)=VR
      IF (T(I).GE.TD) HR(I)=DR*PI/T(I)
   11 CONTINUE
C
C     FORM BASE SPECTRUM
C
      DO 12 I=1,100
```

```
12 Y(I)=HR(I)*AMP(I)
   GO TO 40
15 CONTINUE
   DY=YIN(2)-YIN(1)
   DX=TIN(2)-TIN(1)
   SL=DY/DX
   TI=T(1)
   YI=YIN(1)=SL*(TIN(1)-TI)
   Y(1)=YI
   K=I
   TX=TIN(K)
   YX=YIN(K)
   DO 30 I=2,100
   IF(T(I).GT.TX) GO TO 35
   Y(I)=YI+SL*(T(I)-TI)
   GO TO 30
35 CONTINUE
   IF(K.GE.NDATA) GO TO 34
   K=K+1
   TI=TX
   YI=YX
   TX=TIN(K)
   YX=YIN(K)
   SL=(YX-YI)/(TX-TI)
34 Y(I)=YI+SL*(T(I)-TI)
30 CONTINUE
40 CONTINUE
   CALL PRSPEC(Y,SIG)
   RETURN
   END
```

APPENDIX G

UNITED STATES SEISMICITY TABLES

This appendix contains tables of seismicity for the United States, according to geographical location. Three geographical areas are represented: the continental United States, Alaska and Hawaii. Each of the areas has been subdivided into grid "squares," one-half degree on a side as shown in figures 3.15 through 3.17. Seismicity, A, is herein defined by the relationship

$$\log_{10} N = A - bM$$

for a specified area surrounding a site, where N is the frequency of occurrence (events per year) of earthquakes reported in the area having Richter magnitudes greater than or equal to M, and b is a distribution constant set equal to 0.9. The seismicity of a site is treated as a random variable as discussed in section 3.4. Its statistical parameters including a mean value $\bar{A}$ and a standard deviation σ_A have been computed from past earthquake data. The data include the date, location, and magnitude of events having $M \geq 3.5$. The data were used to construct log N versus M histograms for each site (grid area), which take into account all of the recorded earthquakes close enough to cause potential damage, see figure 3.18. A regression analysis was performed for each grid area to determine values of $\bar{A}$ and σ_A.

The tables which follow contain ten columns of data. The first two columns define the longitude sector of the grid area while the second two columns define the latitude sector. Knowing the geographical coordinates of a particular site, one may go through the table until the appropriate longitude is found and then read down the latitude columns to find the appropriate latitude sector.

Two sets of data appear for each grid area, each containing three columns. These are defined as follows:

A(H) = Mean seismicity $\bar{A}$ based on "Historic" data which includes all recorded data up to the year 1961.

O(H) = Standard deviation σ_A based on Historic data.

R(H) = Effective hypocentral distance to the source of a representative earthquake (defined in the following paragraph) of magnitude M, where M is obtained from the above equation, given N. The inverse of N (i.e., 1/N) may be interpreted as an average return period associated with earthquakes of magnitudes $\geq$ M.

The second set of data including A(N), O(N) and R(N) correspond to the same three parameters above except that NOAA data from 1961 to 1973 form the data base in lieu of the "Historic" data prior to 1961. A discussion of how the two groups of data were used is included in section 3.4. In most cases, the data which produce the higher response spectrum are recommended.

These tables are intended to be used in the following way. First determine an Engineering Seismicity (seismicity used for engineering purposes to establish a representative earthquake of magnitude M). This is defined as where n is specified according to the level of confidence desired in bounding A, e.g., zero, one or two-sigma confidence levels. Specify a return period (1/N) or compute N on the basis of risk parameters defined in section 3.4. Next compute the magnitude M of a representative earthquake (M will represent the maximum probable earthquake having a return period of 1/N). Having computed M, read the appropriate value of effective hypocentral distance, R(H) or R(N), from the tables. Then, M and R specify the magnitude and location of the representative earthquake with respect to the site location.

As pointed out by Algermissen [1.4] the development of seismic zoning maps and the characterization of site seismicity is a "relatively recent development in seismological and engineering research." Therefore, the reader should avail himself of the opportunity to read reference [1.4] so as to better understand this area and the position which the maps presented herein hold in this general field of applied research.

SEISMICITY FOR
THE CONTINENTAL UNITED STATES

* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
1	66.00 - 66.50	43.00 - 43.50	.000	.000	.00	.000	.000	.00
2	66.00 - 66.50	43.50 - 44.00	3.068	.326	124.46	.000	.000	.00
3	66.00 - 66.50	44.00 - 44.50	3.068	.326	89.00	.000	.000	.00
4	66.00 - 66.50	44.50 - 45.00	3.115	.294	56.17	.000	.000	.00
5	66.00 - 66.50	45.00 - 45.50	3.115	.294	20.09	.000	.000	.00
6	66.00 - 66.50	45.50 - 46.00	3.115	.294	55.02	.000	.000	.00
7	66.00 - 66.50	46.00 - 46.50	3.115	.294	86.06	.000	.000	.00
8	66.00 - 66.50	46.50 - 47.00	3.115	.294	115.59	.000	.000	.00
9	66.00 - 66.50	47.00 - 47.50	2.168	.300	99.92	.000	.000	.00
10	66.00 - 66.50	47.50 - 48.00	2.168	.300	126.23	2.294	.225	103.98
11	66.00 - 66.50	48.00 - 48.50	.000	.000	.00	2.294	.225	69.72
12	66.00 - 66.50	48.50 - 49.00	.000	.000	.00	2.294	.225	35.92
13	66.50 - 67.00	43.00 - 43.50	2.169	.000	142.89	.000	.000	.00
14	66.50 - 67.00	43.50 - 44.00	3.102	.278	117.12	.000	.000	.00
15	66.50 - 67.00	44.00 - 44.50	3.102	.278	83.87	.000	.000	.00
16	66.50 - 67.00	44.50 - 45.00	3.145	.251	54.41	.000	.000	.00
17	66.50 - 67.00	45.00 - 45.50	3.145	.251	34.29	.000	.000	.00
18	66.50 - 67.00	45.50 - 46.00	3.145	.251	54.25	.000	.000	.00
19	66.50 - 67.00	46.00 - 46.50	3.145	.251	85.98	.000	.000	.00
20	66.50 - 67.00	46.50 - 47.00	3.115	.294	116.95	.000	.000	.00
21	66.50 - 67.00	47.00 - 47.50	2.168	.300	118.18	.000	.000	.00
22	66.50 - 67.00	47.50 - 48.00	2.469	.300	149.06	2.294	.225	106.39
23	66.50 - 67.00	48.00 - 48.50	.000	.000	.00	2.294	.225	73.27
24	66.50 - 67.00	48.50 - 49.00	.000	.000	.00	2.294	.225	42.40
25	67.00 - 67.50	43.00 - 43.50	2.406	.061	112.98	.000	.000	.00
26	67.00 - 67.50	43.50 - 44.00	3.157	.233	112.26	.000	.000	.00
27	67.00 - 67.50	44.00 - 44.50	3.190	.216	84.64	.000	.000	.00
28	67.00 - 67.50	44.50 - 45.00	3.219	.204	55.58	.000	.000	.00
29	67.00 - 67.50	45.00 - 45.50	3.219	.204	20.70	.000	.000	.00
30	67.00 - 67.50	45.50 - 46.00	3.219	.204	55.96	.000	.000	.00
31	67.00 - 67.50	46.00 - 46.50	3.190	.216	85.65	.000	.000	.00
32	67.00 - 67.50	46.50 - 47.00	3.167	.250	115.50	.000	.000	.00
33	67.00 - 67.50	47.00 - 47.50	2.469	.300	128.58	.000	.000	.00
34	67.00 - 67.50	47.50 - 48.00	2.818	.252	128.35	2.294	.225	113.32
35	67.00 - 67.50	48.00 - 48.50	2.557	.212	118.52	2.294	.225	83.00

* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
36	67.00 - 67.50	48.50 - 49.00	2.557	.212	130.19	2.296	.225	57.61
37	67.50 - 68.00	43.00 - 43.50	2.469	.001	95.45	.000	.000	.00
38	67.50 - 68.00	43.50 - 44.00	3.200	.201	107.39	.000	.000	.00
39	67.50 - 68.00	44.00 - 44.50	3.228	.190	82.36	.000	.000	.00
40	67.50 - 68.00	44.50 - 45.00	3.253	.184	59.71	.000	.000	.00
41	67.50 - 68.00	45.00 - 45.50	3.253	.184	42.75	.000	.000	.00
42	67.50 - 68.00	45.50 - 46.00	3.253	.184	61.39	.000	.000	.00
43	67.50 - 68.00	46.00 - 46.50	3.267	.191	86.87	.000	.000	.00
44	67.50 - 68.00	46.50 - 47.00	3.258	.203	108.57	.000	.000	.00
45	67.50 - 68.00	47.00 - 47.50	2.818	.252	105.48	.000	.000	.00
46	67.50 - 68.00	47.50 - 48.00	3.528	.618	129.95	2.296	.225	124.00
47	67.50 - 68.00	48.00 - 48.50	3.494	.655	132.73	2.296	.225	97.08
48	67.50 - 68.00	48.50 - 49.00	3.494	.655	148.63	2.296	.225	76.52
49	68.00 - 68.50	42.00 - 42.50	2.742	.497	109.36	.000	.000	.00
50	68.00 - 68.50	42.50 - 43.00	2.941	.328	107.13	.000	.000	.00
51	68.00 - 68.50	43.00 - 43.50	2.982	.304	94.36	.000	.000	.00
52	68.00 - 68.50	43.50 - 44.00	3.377	.259	105.91	.000	.000	.00
53	68.00 - 68.50	44.00 - 44.50	3.400	.245	86.23	.000	.000	.00
54	68.00 - 68.50	44.50 - 45.00	3.281	.146	56.44	.000	.000	.00
55	68.00 - 68.50	45.00 - 45.50	3.281	.146	36.57	.000	.000	.00
56	68.00 - 68.50	45.50 - 46.00	3.275	.154	63.65	.000	.000	.00
57	68.00 - 68.50	46.00 - 46.50	3.744	.447	125.86	.000	.000	.00
58	68.00 - 68.50	46.50 - 47.00	3.734	.463	131.82	.000	.000	.00
59	68.00 - 68.50	47.00 - 47.50	3.555	.590	111.34	.000	.000	.00
60	68.00 - 68.50	47.50 - 48.00	3.641	.606	112.73	2.296	.225	137.58
61	68.00 - 68.50	48.00 - 48.50	3.614	.637	118.27	2.296	.225	113.91
62	68.00 - 68.50	48.50 - 49.00	3.614	.637	138.59	2.296	.225	96.98
63	68.50 - 69.00	42.00 - 42.50	3.215	.352	102.97	.000	.000	.00
64	68.50 - 69.00	42.50 - 43.00	3.343	.284	101.18	.000	.000	.00
65	68.50 - 69.00	43.00 - 43.50	3.369	.260	95.69	.000	.000	.00
66	68.50 - 69.00	43.50 - 44.00	3.488	.195	92.70	.000	.000	.00
67	68.50 - 69.00	44.00 - 44.50	3.500	.191	75.59	.000	.000	.00
68	68.50 - 69.00	44.50 - 45.00	3.283	.110	36.68	.000	.000	.00
69	68.50 - 69.00	45.00 - 45.50	3.253	.097	48.78	.000	.000	.00
70	68.50 - 69.00	45.50 - 46.00	3.353	.231	63.07	.000	.000	.00

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*************************************************************************************************
*                              * SEISMIC MAP OF CONTINENTAL U.S. *                              *
*************************************************************************************************
*   GRID     LONG1 - LONG2     LAT1 - LAT2      A(H)   C(H)    R(H)      A(N)   C(N)    R(N)   *
*************************************************************************************************
*                                                                                               *
*    71     68.50 -  69.00    46.00 - 46.50    3.781   .449   109.04     .000   .000     .00   *
*    72     68.50 -  69.00    46.50 - 47.00    3.768   .468   114.97     .000   .000     .00   *
*    73     68.50 -  69.00    47.00 - 47.50    3.665   .580    95.19     .000   .000     .00   *
*    74     68.50 -  69.00    47.50 - 48.00    3.641   .606    84.73    2.294   .225  153.27   *
*    75     68.50 -  69.00    48.00 - 48.50    3.614   .637    92.51    2.294   .225  132.44   *
*    76     68.50 -  69.00    48.50 - 49.00    3.614   .637   117.46    2.294   .225  118.19   *
*    77     69.00 -  69.50    40.00 - 40.50    2.345   .000   134.53    2.744   .503  112.01   *
*    78     69.00 -  69.50    40.50 - 41.00    2.470   .000   113.93    2.744   .503  126.96   *
*    79     69.00 -  69.50    41.00 - 41.50    3.254   .469   118.33    2.744   .503  148.56   *
*    80     69.00 -  69.50    41.50 - 42.00    3.332   .400   100.61     .000   .000     .00   *
*    81     69.00 -  69.50    42.00 - 42.50    3.471   .337    93.88     .000   .000     .00   *
*    82     69.00 -  69.50    42.50 - 43.00    3.545   .295    86.72     .000   .000     .00   *
*    83     69.00 -  69.50    43.00 - 43.50    3.567   .274    86.36     .000   .000     .00   *
*    84     69.00 -  69.50    43.50 - 44.00    3.646   .226    87.06     .000   .000     .00   *
*    85     69.00 -  69.50    44.00 - 44.50    3.656   .220    57.38     .000   .000     .00   *
*    86     69.00 -  69.50    44.50 - 45.00    3.428   .095    59.08     .000   .000     .00   *
*    87     69.00 -  69.50    45.00 - 45.50    3.390   .119    47.19     .000   .000     .00   *
*    88     69.00 -  69.50    45.50 - 46.00    3.357   .227    41.21     .000   .000     .00   *
*    89     69.00 -  69.50    46.00 - 46.50    3.785   .443    72.87     .000   .000     .00   *
*    90     69.00 -  69.50    46.50 - 47.00    3.768   .468   100.21     .000   .000     .00   *
*    91     69.00 -  69.50    47.00 - 47.50    3.665   .580    72.51     .000   .000     .00   *
*    92     69.00 -  69.50    47.50 - 48.00    3.641   .606    55.75     .000   .000     .00   *
*    93     69.00 -  69.50    48.00 - 48.50    3.614   .637    68.09     .000   .000     .00   *
*    94     69.00 -  69.50    48.50 - 49.00    3.614   .637    99.68     .000   .000     .00   *
*    95     69.50 -  70.00    40.00 - 40.50    2.470   .000   125.50    2.744   .503   87.31   *
*    96     69.50 -  70.00    40.50 - 41.00    2.567   .000   100.68    2.744   .503  105.80   *
*    97     69.50 -  70.00    41.00 - 41.50    3.316   .412   106.53    2.744   .503  130.94   *
*    98     69.50 -  70.00    41.50 - 42.00    3.389   .353    84.86     .000   .000     .00   *
*    99     69.50 -  70.00    42.00 - 42.50    3.512   .300    72.64     .000   .000     .00   *
*   100     69.50 -  70.00    42.50 - 43.00    3.577   .265    59.11     .000   .000     .00   *
*   101     69.50 -  70.00    43.00 - 43.50    3.596   .247    67.78     .000   .000     .00   *
*   102     69.50 -  70.00    43.50 - 44.00    3.620   .228    70.33     .000   .000     .00   *
*   103     69.50 -  70.00    44.00 - 44.50    3.630   .222    57.43     .000   .000     .00   *
*   104     69.50 -  70.00    44.50 - 45.00    3.352   .065    53.38     .000   .000     .00   *
*   105     69.50 -  70.00    45.00 - 45.50    3.296   .105    36.91     .000   .000     .00   *
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                       *
**********************************************************************************************
*   GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)     R(H)       A(N)   C(N)    R(N)  *
**********************************************************************************************
*                                                                                            *
*   106    69.50 - 70.00    45.50 - 46.00      3.274   .268    57.97       .000   .000     .00   *
*   107    69.50 - 70.00    46.00 - 46.50      3.738   .485    98.27       .000   .000     .00   *
*   108    69.50 - 70.00    46.50 - 47.00      3.716   .517    87.16       .000   .000     .00   *
*   109    69.50 - 70.00    47.00 - 47.50      3.665   .580    54.50       .000   .000     .00   *
*   110    69.50 - 70.00    47.50 - 48.00      3.641   .606    28.18       .000   .000     .00   *
*   111    69.50 - 70.00    48.00 - 48.50      3.614   .637    46.91       .000   .000     .00   *
*   112    69.50 - 70.00    48.50 - 49.00      3.614   .637    88.02       .000   .000     .00   *
*   113    70.00 - 70.50    40.00 - 40.50      2.470   .000   114.06      2.894   .375   75.43   *
*   114    70.00 - 70.50    40.50 - 41.00      2.567   .000    86.52      2.744   .503   87.61   *
*   115    70.00 - 70.50    41.00 - 41.50      3.316   .412    91.62      2.744   .503  116.73   *
*   116    70.00 - 70.50    41.50 - 42.00      3.389   .353    66.57       .000   .000     .00   *
*   117    70.00 - 70.50    42.00 - 42.50      3.512   .300    55.45       .000   .000     .00   *
*   118    70.00 - 70.50    42.50 - 43.00      3.577   .265    28.46       .000   .000     .00   *
*   119    70.00 - 70.50    43.00 - 43.50      3.599   .244    51.43       .000   .000     .00   *
*   120    70.00 - 70.50    43.50 - 44.00      3.623   .225    51.68       .000   .000     .00   *
*   121    70.00 - 70.50    44.00 - 44.50      3.634   .218    47.91       .000   .000     .00   *
*   122    70.00 - 70.50    44.50 - 45.00      3.358   .057    42.92       .000   .000     .00   *
*   123    70.00 - 70.50    45.00 - 45.50      3.303   .095    54.81       .000   .000     .00   *
*   124    70.00 - 70.50    45.50 - 46.00      3.279   .264    70.41       .000   .000     .00   *
*   125    70.00 - 70.50    46.00 - 46.50      3.742   .479   109.02       .000   .000     .00   *
*   126    70.00 - 70.50    46.50 - 47.00      3.716   .517    82.27       .000   .000     .00   *
*   127    70.00 - 70.50    47.00 - 47.50      3.665   .580    44.34       .000   .000     .00   *
*   128    70.00 - 70.50    47.50 - 48.00      3.693   .621    15.97       .000   .000     .00   *
*   129    70.00 - 70.50    48.00 - 48.50      3.667   .651    48.90       .000   .000     .00   *
*   130    70.00 - 70.50    48.50 - 49.00      3.614   .637    85.10       .000   .000     .00   *
*   131    70.50 - 71.00    40.00 - 40.50      2.970   .310   117.01      2.894   .375   53.47   *
*   132    70.50 - 71.00    40.50 - 41.00      2.982   .304    89.72      2.744   .503   74.60   *
*   133    70.50 - 71.00    41.00 - 41.50      3.460   .396    87.34      2.744   .503  107.31   *
*   134    70.50 - 71.00    41.50 - 42.00      3.513   .352    47.20       .000   .000     .00   *
*   135    70.50 - 71.00    42.00 - 42.50      3.609   .313    48.52       .000   .000     .00   *
*   136    70.50 - 71.00    42.50 - 43.00      3.663   .284    29.22       .000   .000     .00   *
*   137    70.50 - 71.00    43.00 - 43.50      3.679   .268    39.68       .000   .000     .00   *
*   138    70.50 - 71.00    43.50 - 44.00      3.609   .237    40.93       .000   .000     .00   *
*   139    70.50 - 71.00    44.00 - 44.50      3.620   .228    43.69       .000   .000     .00   *
*   140    70.50 - 71.00    44.50 - 45.00      3.335   .049    41.63       .000   .003     .00   *
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**************************************************************************************************
*                         * SEISMIC MAP OF CONTINENTAL U.S. *                                    *
**************************************************************************************************
*  GRID     LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)   C(N)    R(N)  *
**************************************************************************************************
*                                                                                                *
*   141     70.50 -  71.00    45.00 - 45.50      3.381   .228    53.61       .000   .000     .00  *
*   142     70.50 -  71.00    45.50 - 46.00      3.410   .367    91.8[illegible]  .000   .000     .00  *
*   143     70.50 -  71.00    46.00 - 46.50      3.777   .510   117.25       .000   .000     .00  *
*   144     70.50 -  71.00    46.50 - 47.00      3.749   .551    84.48       .000   .000     .00  *
*   145     70.50 -  71.00    47.00 - 47.50      3.715   .597    36.60       .000   .000     .00  *
*   146     70.50 -  71.00    47.50 - 48.00      3.693   .621    31.83       .000   .000     .00  *
*   147     70.50 -  71.00    48.00 - 48.50      3.667   .651    57.27       .000   .000     .00  *
*   148     70.50 -  71.00    48.50 - 49.00      3.614   .637    90.20       .000   .000     .00  *
*   149     71.00 -  71.50    39.00 - 39.50      3.775   .232   220.42      3.369   .419   75.77  *
*   150     71.00 -  71.50    39.50 - 40.00      3.841   .203   201.95      3.369   .419   24.41  *
*   151     71.00 -  71.50    40.00 - 40.50      2.992   .300   103.43      2.894   .375   43.26  *
*   152     71.00 -  71.50    40.50 - 41.00      3.002   .298    78.58      2.744   .503   69.72  *
*   153     71.00 -  71.50    41.00 - 41.50      3.472   .386    82.40      2.744   .503  103.98  *
*   154     71.00 -  71.50    41.50 - 42.00      3.522   .346    52.48       .000   .000     .00  *
*   155     71.00 -  71.50    42.00 - 42.50      3.620   .302    55.03       .000   .000     .00  *
*   156     71.00 -  71.50    42.50 - 43.00      3.676   .271    28.72       .000   .000     .00  *
*   157     71.00 -  71.50    43.00 - 43.50      3.698   .251    42.22       .000   .000     .00  *
*   158     71.00 -  71.50    43.50 - 44.00      3.627   .221    34.16       .000   .000     .00  *
*   159     71.00 -  71.50    44.00 - 44.50      3.637   .215    62.95       .000   .000     .00  *
*   160     71.00 -  71.50    44.50 - 45.00      3.363   .050    46.80       .000   .000     .00  *
*   161     71.00 -  71.50    45.00 - 45.50      3.401   .219    75.19       .000   .000     .00  *
*   162     71.00 -  71.50    45.50 - 46.00      3.431   .354   101.03       .000   .000     .00  *
*   163     71.00 -  71.50    46.00 - 46.50      3.786   .503   124.07       .000   .000     .00  *
*   164     71.00 -  71.50    46.50 - 47.00      3.749   .551    94.18       .000   .000     .00  *
*   165     71.50 -  72.00    39.00 - 39.50      3.775   .232   209.82      3.429   .397   89.09  *
*   166     71.50 -  72.00    39.50 - 40.00      3.841   .203   191.05      3.429   .397   69.06  *
*   167     71.50 -  72.00    40.00 - 40.50      3.078   .246    93.56      2.894   .375   52.70  *
*   168     71.50 -  72.00    40.50 - 41.00      3.085   .245    71.74      2.744   .503   74.60  *
*   169     71.50 -  72.00    41.00 - 41.50      3.513   .352    79.40      2.744   .503  107.31  *
*   170     71.50 -  72.00    41.50 - 42.00      3.595   .304    57.44       .000   .000     .00  *
*   171     71.50 -  72.00    42.00 - 42.50      3.679   .268    65.37       .000   .000     .00  *
*   172     71.50 -  72.00    42.50 - 43.00      3.695   .271    45.20       .000   .000     .00  *
*   173     71.50 -  72.00    43.00 - 43.50      3.726   .242    49.52       .000   .000     .00  *
*   174     71.50 -  72.00    43.50 - 44.00      3.656   .215    61.23       .000   .000     .00  *
*   175     71.50 -  72.00    44.00 - 44.50      3.703   .221    81.01       .000   .000     .00  *
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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                              *
**************************************************************************************************
*   GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)   D(H)    R(H)        A(N)   D(N)    R(N)   *
**************************************************************************************************
*                                                                                                *
*   176     71.50 -  72.00    44.50 - 45.00     3.439  .210    68.31       .000   .000     .00   *
*   177     71.50 -  72.00    45.00 - 45.50     3.506  .319    95.87       .000   .000     .00   *
*   178     71.50 -  72.00    45.50 - 46.00     3.479  .449   109.68       .000   .000     .00   *
*   179     71.50 -  72.00    46.00 - 46.50     3.808  .540   128.77       .000   .000     .00   *
*   180     71.50 -  72.00    46.50 - 47.00     3.746  .618   102.82       .000   .000     .00   *
*   181     72.00 -  72.50    39.00 - 39.50     3.775  .232   199.86      3.429   .397   98.59   *
*   182     72.00 -  72.50    39.50 - 40.00     3.841  .203   180.36      3.429   .397  109.06   *
*   183     72.00 -  72.50    40.00 - 40.50     3.275  .165    93.50      2.894   .375   72.41   *
*   184     72.00 -  72.50    40.50 - 41.00     3.280  .162    72.24      2.744   .503   87.61   *
*   185     72.00 -  72.50    41.00 - 41.50     3.605  .315    73.21      2.744   .503  116.73   *
*   186     72.00 -  72.50    41.50 - 42.00     3.673  .274    59.33       .000   .000     .00   *
*   187     72.00 -  72.50    42.00 - 42.50     3.740  .246    73.53       .000   .000     .00   *
*   188     72.00 -  72.50    42.50 - 43.00     3.708  .260    70.22       .000   .000     .00   *
*   189     72.00 -  72.50    43.00 - 43.50     3.768  .221    76.48       .000   .000     .00   *
*   190     72.00 -  72.50    43.50 - 44.00     3.684  .208    79.38       .000   .000     .00   *
*   191     72.00 -  72.50    44.00 - 44.50     3.725  .212    89.40       .000   .000     .00   *
*   192     72.00 -  72.50    44.50 - 45.00     3.469  .216    57.86       .000   .000     .00   *
*   193     72.00 -  72.50    45.00 - 45.50     3.537  .311    95.17       .000   .000     .00   *
*   194     72.00 -  72.50    45.50 - 46.00     3.524  .427   107.21       .000   .000     .00   *
*   195     72.50 -  73.00    39.00 - 39.50     3.784  .225   189.59      3.429   .397  116.11   *
*   196     72.50 -  73.00    39.50 - 40.00     3.848  .195   169.22      3.429   .397  134.04   *
*   197     72.50 -  73.00    40.00 - 40.50     3.304  .133    82.74      2.894   .375   94.08   *
*   198     72.50 -  73.00    40.50 - 41.00     3.310  .129    62.47      2.744   .503  105.80   *
*   199     72.50 -  73.00    41.00 - 41.50     3.557  .260    51.25      2.744   .503  130.94   *
*   200     72.50 -  73.00    41.50 - 42.00     3.630  .217    27.35       .000   .000     .00   *
*   201     72.50 -  73.00    42.00 - 42.50     3.698  .194    70.19       .000   .000     .00   *
*   202     72.50 -  73.00    42.50 - 43.00     3.644  .225    78.65       .000   .000     .00   *
*   203     72.50 -  73.00    43.00 - 43.50     3.777  .230    90.07       .000   .000     .00   *
*   204     72.50 -  73.00    43.50 - 44.00     3.694  .224    84.76       .000   .000     .00   *
*   205     72.50 -  73.00    44.00 - 44.50     3.732  .225    86.43       .000   .000     .00   *
*   206     72.50 -  73.00    44.50 - 45.00     3.599  .188    72.31      2.071   .000  141.13   *
*   207     72.50 -  73.00    45.00 - 45.50     3.628  .337    93.00      2.071   .000  118.18   *
*   208     72.50 -  73.00    45.50 - 46.00     3.617  .443   102.01      2.071   .000  101.96   *
*   209     73.00 -  73.50    38.00 - 38.50     3.532  .009   183.00      3.429   .397  108.00   *
*   210     73.00 -  73.50    38.50 - 39.00     3.834  .242   220.33      3.497   .359  129.75   *
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                              * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID.   LONG1 - LONG2    LAT1 - LAT2       A(H)    B(H)    R(H)       A(N)    B(N)    R(N)

   211    73.00 - 73.50    39.00 - 39.50     3.877   .216   194.71      3.497   .359   144.81
   212    73.00 - 73.50    39.50 - 40.00     3.930   .193   171.02      3.497   .359   162.12
   213    73.00 - 73.50    40.00 - 40.50     3.299   .138    69.35      2.894   .375   116.35
   214    73.00 - 73.50    40.50 - 41.00     3.299   .138    48.95      2.744   .503   126.96
   215    73.00 - 73.50    41.00 - 41.50     3.464   .208    45.07      2.744   .503   148.56
   216    73.00 - 73.50    41.50 - 42.00     3.527   .181    43.60       .000   .000      .00
   217    73.00 - 73.50    42.00 - 42.50     3.589   .177    70.14       .000   .000      .00
   218    73.00 - 73.50    42.50 - 43.00     3.486   .226    72.02       .000   .000      .00
   219    73.00 - 73.50    43.00 - 43.50     3.679   .215    77.92       .000   .000      .00
   220    73.00 - 73.50    43.50 - 44.00     3.601   .199    61.49       .000   .000      .00
   221    73.00 - 73.50    44.00 - 44.50     3.668   .212    63.70      2.071   .000   126.23
   222    73.00 - 73.50    44.50 - 45.00     3.579   .211    43.71      2.071   .000    99.92
   223    73.00 - 73.50    45.00 - 45.50     3.623   .344    77.25      2.071   .000    80.08
   224    73.00 - 73.50    45.50 - 46.00     3.560   .377    71.21      3.429   .397   101.18
   225    73.50 - 74.00    38.00 - 38.50     3.583   .051   179.04      3.497   .359   136.21
   226    73.50 - 74.00    38.50 - 39.00     3.867   .228   214.95      3.497   .359   155.58
   227    73.50 - 74.00    39.00 - 39.50     3.914   .198   191.50      3.497   .359   172.99
   228    73.50 - 74.00    39.50 - 40.00     3.961   .180   165.79      2.296   .225   131.63
   229    73.50 - 74.00    40.00 - 40.50     3.383   .120    62.18       .000   .000      .00
   230    73.50 - 74.00    40.50 - 41.00     3.376   .129    29.50       .000   .000      .00
   231    73.50 - 74.00    41.00 - 41.50     3.401   .108    40.92       .000   .000      .00
   232    73.50 - 74.00    41.50 - 42.00     3.416   .078    52.74       .000   .000      .00
   233    73.50 - 74.00    42.00 - 42.50     3.437   .059    66.59       .000   .000      .00
   234    73.50 - 74.00    42.50 - 43.00     3.261   .144    54.77       .000   .000      .00
   235    73.50 - 74.00    43.00 - 43.50     3.550   .167    41.06       .000   .000      .00
   236    73.50 - 74.00    43.50 - 44.00     3.439   .130    48.43       .000   .000      .00
   237    73.50 - 74.00    44.00 - 44.50     3.557   .191    59.47       .000   .000      .00
   238    73.50 - 74.00    44.50 - 45.00     3.540   .209    39.66      2.071   .000   114.41
   239    73.50 - 74.00    45.00 - 45.50     3.589   .344    64.19      2.071   .000    84.48
   240    73.50 - 74.00    45.50 - 46.00     3.560   .377    36.45      2.071   .000    59.72
   241    74.00 - 74.50    34.00 - 34.50     2.978   .054   277.09      3.179   .447   203.36
   242    74.00 - 74.50    34.50 - 35.00     3.109   .129   256.83      3.241   .391   177.56
   243    74.00 - 74.50    35.00 - 35.50     3.134   .123   234.30      3.241   .391   140.27
   244    74.00 - 74.50    35.50 - 36.00     3.258   .082   244.02      3.365   .419   118.57
   245    74.00 - 74.50    36.00 - 36.50     3.274   .060   223.75      3.429   .397    79.63
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* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
246	74.00 - 74.50	36.50 - 37.00	3.487	.098	232.61	3.429	.397	29.65
247	74.00 - 74.50	37.00 - 37.50	3.506	.071	210.01	3.429	.397	17.02
248	74.00 - 74.50	37.50 - 38.00	3.580	.053	188.31	3.429	.397	56.72
249	74.00 - 74.50	38.00 - 38.50	3.583	.051	168.22	3.429	.397	98.30
250	74.00 - 74.50	38.50 - 39.00	3.867	.228	204.01	3.497	.359	139.46
251	74.00 - 74.50	39.00 - 39.50	3.916	.197	182.68	3.497	.359	161.75
252	74.00 - 74.50	39.50 - 40.00	3.963	.178	158.68	3.497	.359	178.79
253	74.00 - 74.50	40.00 - 40.50	3.383	.120	57.27	2.294	.225	149.65
254	74.00 - 74.50	40.50 - 41.00	3.376	.129	23.48	.000	.000	.00
255	74.00 - 74.50	41.00 - 41.50	3.381	.122	40.68	.000	.000	.00
256	74.00 - 74.50	41.50 - 42.00	3.389	.104	41.03	.000	.000	.00
257	74.00 - 74.50	42.00 - 42.50	3.408	.087	70.36	.000	.000	.00
258	74.00 - 74.50	42.50 - 43.00	3.213	.179	43.11	.000	.000	.00
259	74.00 - 74.50	43.00 - 43.50	3.523	.192	54.21	.000	.000	.00
260	74.00 - 74.50	43.50 - 44.00	3.412	.154	58.36	.000	.000	.00
261	74.00 - 74.50	44.00 - 44.50	3.536	.216	48.43	.000	.000	.00
262	74.00 - 74.50	44.50 - 45.00	3.532	.223	29.18	2.071	.000	106.68
263	74.00 - 74.50	45.00 - 45.50	3.589	.344	59.87	2.071	.000	73.69
264	74.00 - 74.50	45.50 - 46.00	3.560	.377	66.88	2.372	.000	61.12
265	74.50 - 75.00	34.00 - 34.50	2.978	.054	258.89	3.179	.447	205.37
266	74.50 - 75.00	34.50 - 35.00	3.109	.129	240.58	3.241	.391	180.35
267	74.50 - 75.00	35.00 - 35.50	3.134	.123	218.37	3.241	.391	143.79
268	74.50 - 75.00	35.50 - 36.00	3.258	.082	226.64	3.365	.419	124.34
269	74.50 - 75.00	36.00 - 36.50	3.274	.060	206.35	3.429	.397	91.01
270	74.50 - 75.00	36.50 - 37.00	3.487	.098	217.18	3.429	.397	57.58
271	74.50 - 75.00	37.00 - 37.50	3.506	.071	195.61	3.429	.397	45.88
272	74.50 - 75.00	37.50 - 38.00	3.580	.053	176.80	3.429	.397	69.53
273	74.50 - 75.00	38.00 - 38.50	3.583	.051	156.12	3.429	.397	105.36
274	74.50 - 75.00	38.50 - 39.00	3.867	.228	190.30	3.497	.359	145.45
275	74.50 - 75.00	39.00 - 39.50	3.923	.191	173.20	3.497	.359	166.27
276	74.50 - 75.00	39.50 - 40.00	3.969	.174	152.33	3.497	.359	180.08
277	74.50 - 75.00	40.00 - 40.50	3.383	.120	59.13	2.521	.367	105.80
278	74.50 - 75.00	40.50 - 41.00	3.376	.129	35.20	2.521	.367	111.28
279	74.50 - 75.00	41.00 - 41.50	3.381	.122	55.73	2.521	.367	126.31
280	74.50 - 75.00	41.50 - 42.00	3.389	.104	66.27	2.521	.367	148.01

• SEISMIC MAP OF CONTINENTAL U.S. •

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
281	74.50 - 75.00	42.00 - 42.50	3.408	.087	80.17	.000	.000	.00
282	74.50 - 75.00	42.50 - 43.00	3.213	.179	63.97	.000	.000	.00
283	74.50 - 75.00	43.00 - 43.50	3.519	.198	61.56	.000	.000	.00
284	74.50 - 75.00	43.50 - 44.00	3.438	.180	66.02	.000	.000	.00
285	74.50 - 75.00	44.00 - 44.50	3.556	.223	56.81	.000	.000	.00
286	74.50 - 75.00	44.50 - 45.00	3.551	.230	24.59	2.074	.000	103.98
287	74.50 - 75.00	45.00 - 45.50	3.610	.345	57.19	2.074	.000	69.72
288	74.50 - 75.00	45.50 - 46.00	3.582	.379	81.80	2.372	.000	51.41
289	75.00 - 75.50	34.00 - 34.50	2.978	.054	240.97	3.179	.447	211.26
290	75.00 - 75.50	34.50 - 35.00	3.109	.129	224.94	3.244	.391	187.92
291	75.00 - 75.50	35.00 - 35.50	3.134	.123	203.23	3.244	.391	153.36
292	75.00 - 75.50	35.50 - 36.00	3.258	.082	210.11	3.365	.419	138.90
293	75.00 - 75.50	36.00 - 36.50	3.274	.060	189.66	3.429	.397	114.10
294	75.00 - 75.50	36.50 - 37.00	3.740	.372	243.06	3.482	.380	95.63
295	75.00 - 75.50	37.00 - 37.50	3.528	.076	184.82	3.482	.380	87.61
296	75.00 - 75.50	37.50 - 38.00	3.580	.053	164.88	3.429	.397	95.50
297	75.00 - 75.50	38.00 - 38.50	3.583	.051	141.60	3.429	.397	120.91
298	75.00 - 75.50	38.50 - 39.00	3.867	.228	165.79	3.497	.359	154.99
299	75.00 - 75.50	39.00 - 39.50	3.923	.191	157.82	3.497	.359	169.66
300	75.00 - 75.50	39.50 - 40.00	3.969	.174	133.72	3.497	.359	175.48
301	75.00 - 75.50	40.00 - 40.50	3.233	.112	41.46	2.524	.367	79.63
302	75.00 - 75.50	40.50 - 41.00	3.222	.123	45.64	2.524	.367	86.78
303	75.00 - 75.50	41.00 - 41.50	3.230	.115	59.83	2.524	.367	105.36
304	75.00 - 75.50	41.50 - 42.00	3.242	.090	75.77	2.524	.367	130.58
305	75.00 - 75.50	42.00 - 42.50	3.275	.068	88.30	.000	.000	.00
306	75.00 - 75.50	42.50 - 43.00	2.881	.153	57.01	.000	.000	.00
307	75.00 - 75.50	43.00 - 43.50	3.380	.127	76.31	.000	.000	.00
308	75.00 - 75.50	43.50 - 44.00	3.438	.180	67.95	.000	.000	.00
309	75.00 - 75.50	44.00 - 44.50	3.556	.223	65.03	.000	.000	.00
310	75.00 - 75.50	44.50 - 45.00	3.551	.230	38.80	2.074	.000	106.68
311	75.00 - 75.50	45.00 - 45.50	3.512	.257	36.72	2.074	.000	73.69
312	75.00 - 75.50	45.50 - 46.00	3.483	.294	77.56	2.372	.000	59.19
313	75.50 - 76.00	34.00 - 34.50	3.602	.429	264.69	3.273	.411	230.33
314	75.50 - 76.00	34.50 - 35.00	3.635	.410	261.41	3.324	.367	209.81
315	75.50 - 76.00	35.00 - 35.50	3.644	.402	256.11	3.324	.367	179.72

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*                           * SEISMIC MAP OF CONTINENTAL U.S. *                           *
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*   GFID    LONG1 - LONG2     LAT1 - LAT2         A(H)    B(H)    R(H)       A(N)   B(N)    R(N)   *
*******************************************************************************************
*                                                                                         *
*   316    75.50 -  76.00    35.50 - 36.00       3.669   .395   251.76     3.429   .397   169.34   *
*   317    75.50 -  76.00    36.00 - 36.50       3.675   .390   239.19     3.482   .380   149.20   *
*   318    75.50 -  76.00    36.50 - 37.00       3.858   .285   247.52     3.509   .340   133.01   *
*   319    75.50 -  76.00    37.00 - 37.50       3.611   .104   176.00     3.509   .340   126.93   *
*   320    75.50 -  76.00    37.50 - 38.00       3.722   .118   176.77     3.446   .373   125.99   *
*   321    75.50 -  76.00    38.00 - 38.50       3.737   .107   153.13     3.446   .373   142.75   *
*   322    75.50 -  76.00    38.50 - 39.00       3.903   .222   110.58     3.509   .340   167.77   *
*   323    75.50 -  76.00    39.00 - 39.50       3.955   .187   150.08     3.509   .340   172.35   *
*   324    75.50 -  76.00    39.50 - 40.00       3.993   .177    83.46     3.509   .340   163.13   *
*   325    75.50 -  76.00    40.00 - 40.50       3.228   .117    51.17     2.521   .367    53.60   *
*   326    75.50 -  76.00    40.50 - 41.00       3.216   .128    31.04     2.521   .367    63.75   *
*   327    75.50 -  76.00    41.00 - 41.50       3.213   .132    67.43     2.521   .367    87.37   *
*   328    75.50 -  76.00    41.50 - 42.00       3.228   .100    89.79     2.521   .367   116.56   *
*   329    75.50 -  76.00    42.00 - 42.50       3.254   .091   103.20      .000   .000      .00   *
*   330    75.50 -  76.00    42.50 - 43.00       2.839   .107    70.31      .000   .000      .00   *
*   331    75.50 -  76.00    43.00 - 43.50       3.335   .177    86.53      .000   .000      .00   *
*   332    75.50 -  76.00    43.50 - 44.00       3.401   .218    46.96      .000   .000      .00   *
*   333    75.50 -  76.00    44.00 - 44.50       3.527   .260    75.71      .000   .000      .00   *
*   334    75.50 -  76.00    44.50 - 45.00       3.521   .270    53.08     2.372   .000   125.98   *
*   335    75.50 -  76.00    45.00 - 45.50       3.476   .306    61.91     2.372   .000    97.76   *
*   336    75.50 -  76.00    45.50 - 46.00       3.447   .340    65.95     2.548   .000    81.69   *
*   337    76.00 -  76.50    33.00 - 33.50       3.660   .446   263.95     3.317   .349   283.80   *
*   338    76.00 -  76.50    33.50 - 34.00       3.744   .366   268.41     3.317   .349   261.89   *
*   339    76.00 -  76.50    34.00 - 34.50       3.744   .366   267.71     3.317   .349   239.51   *
*   340    76.00 -  76.50    34.50 - 35.00       3.773   .339   265.87     3.358   .313   223.32   *
*   341    76.00 -  76.50    35.00 - 35.50       3.781   .328   260.87     3.358   .313   198.99   *
*   342    76.00 -  76.50    35.50 - 36.00       3.799   .322   254.66     3.358   .313   175.54   *
*   343    76.00 -  76.50    36.00 - 36.50       3.804   .315   241.01     3.416   .303   163.34   *
*   344    76.00 -  76.50    36.50 - 37.00       3.871   .274   225.05     3.535   .318   168.39   *
*   345    76.00 -  76.50    37.00 - 37.50       3.636   .088   158.86     3.535   .318   163.13   *
*   346    76.00 -  76.50    37.50 - 38.00       3.739   .103   161.60     3.477   .346   157.80   *
*   347    76.00 -  76.50    38.00 - 38.50       3.751   .096   147.87     3.477   .346   167.55   *
*   348    76.00 -  76.50    38.50 - 39.00       3.874   .181   151.67     3.535   .318   183.16   *
*   349    76.00 -  76.50    39.00 - 39.50       3.918   .153   150.64     3.535   .318   175.75   *
*   350    76.00 -  76.50    39.50 - 40.00       3.952   .149   134.38     3.535   .318   142.54   *
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*************************************************************************************************
*                               * SEISMIC MAP OF CONTINENTAL U.S. *                             *
*************************************************************************************************
*   GRID     LONG1 - LONG2      LAT1 - LAT2         A(H)    C(H)     R(H)      A(N)   C(N)    R(N)    *
*************************************************************************************************
*                                                                                               *
*    351     76.00 -  76.50    40.00 - 40.50       3.269   .113     48.73     2.521   .367    28.17  *
*    352     76.00 -  76.50    40.50 - 41.00       3.159   .166     58.10     2.521   .367    44.54  *
*    353     76.00 -  76.50    41.00 - 41.50       3.289   .218     90.29     2.881   .298   100.12  *
*    354     76.00 -  76.50    41.50 - 42.00       3.244   .192    104.89     2.881   .298   116.39  *
*    355     76.00 -  76.50    42.00 - 42.50       3.260   .184    113.96     2.621   .255   107.51  *
*    356     76.00 -  76.50    42.50 - 43.00       2.982   .304     89.75     2.621   .255   101.83  *
*    357     76.00 -  76.50    43.00 - 43.50       3.378   .296    105.21     2.621   .255   107.51  *
*    358     76.00 -  76.50    43.50 - 44.00       3.447   .306     88.21     2.621   .253   123.00  *
*    359     76.00 -  76.50    44.00 - 44.50       3.447   .306     86.07     2.621   .255   145.19  *
*    360     76.00 -  76.50    44.50 - 45.00       3.319   .257     64.42     2.372   .000   126.23  *
*    361     76.00 -  76.50    45.00 - 45.50       3.298   .290     60.15     2.372   .000    99.91  *
*    362     76.00 -  76.50    45.50 - 46.00       3.267   .312     80.98     2.548   .000    86.37  *
*    363     76.50 -  77.00    33.00 - 33.50       3.716   .382    237.58     3.358   .313   285.37  *
*    364     76.50 -  77.00    33.50 - 34.00       3.781   .328    239.83     3.358   .313   266.99  *
*    365     76.50 -  77.00    34.00 - 34.50       3.781   .328    239.91     3.358   .313   248.97  *
*    366     76.50 -  77.00    34.50 - 35.00       3.804   .310    240.34     3.392   .285   236.08  *
*    367     76.50 -  77.00    35.00 - 35.50       3.810   .302    237.75     3.392   .285   216.98  *
*    368     76.50 -  77.00    35.50 - 36.00       3.827   .296    233.22     3.392   .285   198.79  *
*    369     76.50 -  77.00    36.00 - 36.50       3.831   .291    219.57     3.446   .278   190.25  *
*    370     76.50 -  77.00    36.50 - 37.00       3.883   .273    205.68     3.511   .244   186.65  *
*    371     76.50 -  77.00    37.00 - 37.50       3.664   .108    142.29     3.511   .244   182.75  *
*    372     76.50 -  77.00    37.50 - 38.00       3.768   .102    144.16     3.457   .261   176.38  *
*    373     76.50 -  77.00    38.00 - 38.50       3.779   .095    139.43     3.446   .278   179.79  *
*    374     76.50 -  77.00    38.50 - 39.00       3.847   .139    147.02     3.502   .259   187.97  *
*    375     76.50 -  77.00    39.00 - 39.50       3.869   .115    145.71     3.502   .259   172.38  *
*    376     76.50 -  77.00    39.50 - 40.00       3.877   .110    143.78     3.502   .259   121.49  *
*    377     76.50 -  77.00    40.00 - 40.50       3.039   .116     62.73     2.521   .367    10.00  *
*    378     76.50 -  77.00    40.50 - 41.00       2.885   .067     65.11     2.521   .367    35.92  *
*    379     76.50 -  77.00    41.00 - 41.50       3.115   .277    102.33     2.881   .298    92.10  *
*    380     76.50 -  77.00    41.50 - 42.00       3.055   .265    104.00     2.881   .298   104.44  *
*    381     76.50 -  77.00    42.00 - 42.50       3.068   .281    100.11     2.621   .255    84.06  *
*    382     76.50 -  77.00    42.50 - 43.00       2.954   .343     86.38     2.621   .255    76.66  *
*    383     76.50 -  77.00    43.00 - 43.50       3.275   .368    106.23     2.621   .255    84.06  *
*    384     76.50 -  77.00    43.50 - 44.00       3.384   .345    106.60     2.621   .255   103.14  *
*    385     76.50 -  77.00    44.00 - 44.50       3.384   .345    100.80     2.621   .255   128.80  *
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***************************************************************************************************
*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                            *
***************************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2          A(H)    B(H)    R(H)         A(N)    B(N)    R(N)  *
***************************************************************************************************
*                                                                                                 *
*   386    76.50 - 77.00    44.50 - 45.00        3.253   .281    75.53        2.372   .000  125.98  *
*   387    76.50 - 77.00    45.00 - 45.50        3.204   .329    33.84        2.372   .000   97.76  *
*   388    76.50 - 77.00    45.50 - 46.00        3.160   .363    79.45        2.548   .000   81.69  *
*   389    77.00 - 77.50    32.00 - 32.50        3.585   .440   186.47        2.680   .206  183.80  *
*   390    77.00 - 77.50    32.50 - 33.00        3.591   .433   181.21        2.922   .255  214.69  *
*   391    77.00 - 77.50    33.00 - 33.50        3.744   .366   210.60        3.440   .269  281.47  *
*   392    77.00 - 77.50    33.50 - 34.00        3.802   .318   212.88        3.440   .269  267.12  *
*   393    77.00 - 77.50    34.00 - 34.50        3.802   .318   212.74        3.440   .269  254.19  *
*   394    77.00 - 77.50    34.50 - 35.00        3.821   .304   218.57        3.440   .269  241.34  *
*   395    77.00 - 77.50    35.00 - 35.50        3.827   .296   220.68        3.440   .269  228.24  *
*   396    77.00 - 77.50    35.50 - 36.00        3.842   .293   217.58        3.440   .269  215.69  *
*   397    77.00 - 77.50    36.00 - 36.50        3.846   .288   203.59        3.487   .264  210.07  *
*   398    77.00 - 77.50    36.50 - 37.00        3.909   .264   186.49        3.574   .218  212.13  *
*   399    77.00 - 77.50    37.00 - 37.50        3.711   .128   122.92        3.574   .218  208.27  *
*   400    77.00 - 77.50    37.50 - 38.00        3.812   .096   114.70        3.531   .227  202.47  *
*   401    77.00 - 77.50    38.00 - 38.50        3.821   .092   122.26        3.524   .241  202.64  *
*   402    77.00 - 77.50    38.50 - 39.00        3.879   .131   133.41        3.569   .229  204.76  *
*   403    77.00 - 77.50    39.00 - 39.50        3.897   .112   135.21        3.569   .229  189.30  *
*   404    77.00 - 77.50    39.50 - 40.00        3.904   .106   151.06        3.569   .229  150.32  *
*   405    77.00 - 77.50    40.00 - 40.50        2.998   .083    76.02        2.921   .367   28.17  *
*   406    77.00 - 77.50    40.50 - 41.00        2.802   .107    79.10        2.921   .367   44.54  *
*   407    77.00 - 77.50    41.00 - 41.50        3.062   .317   112.77        2.081   .298   92.53  *
*   408    77.00 - 77.50    41.50 - 42.00        3.008   .285    98.00        2.081   .298   94.94  *
*   409    77.00 - 77.50    42.00 - 42.50        3.027   .294    81.45        2.621   .255   62.11  *
*   410    77.00 - 77.50    42.50 - 43.00        2.954   .343    64.54        2.621   .255   51.65  *
*   411    77.00 - 77.50    43.00 - 43.50        3.027   .294    75.12        2.621   .255   62.11  *
*   412    77.00 - 77.50    43.50 - 44.00        3.212   .253   100.27        2.621   .255   86.19  *
*   413    77.00 - 77.50    44.00 - 44.50        3.212   .253   103.77        2.621   .255  115.67  *
*   414    77.00 - 77.50    44.50 - 45.00        3.010   .199    77.42        2.071   .000  106.68  *
*   415    77.50 - 78.00    32.00 - 32.50        3.608   .424   161.68        2.680   .206  159.37  *
*   416    77.50 - 78.00    32.50 - 33.00        3.627   .411   157.95        2.922   .255  189.93  *
*   417    77.50 - 78.00    33.00 - 33.50        3.773   .339   184.28        3.477   .233  270.05  *
*   418    77.50 - 78.00    33.50 - 34.00        3.824   .300   184.62        3.477   .233  259.10  *
*   419    77.50 - 78.00    34.00 - 34.50        3.815   .306   174.06        3.477   .233  250.72  *
*   420    77.50 - 78.00    34.50 - 35.00        3.832   .295   193.41        3.477   .233  242.51  *
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                               *
*****************************************************************************************************
*  GFIC      LONG1 - LONG2       LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)    R(N)   *
*****************************************************************************************************
*                                                                                                   *
*   421      77.50 -  78.00     35.00 - 35.50      3.853    .284   205.38      3.477    .233   233.56  *
*   422      77.50 -  78.00     35.50 - 36.00      3.873    .278   204.09      3.520    .232   231.58  *
*   423      77.50 -  78.00     36.00 - 36.50      3.877    .274   190.21      3.557    .233   225.82  *
*   424      77.50 -  78.00     36.50 - 37.00      3.936    .253   170.77      3.557    .233   218.95  *
*   425      77.50 -  78.00     37.00 - 37.50      3.758    .143   105.17      3.557    .233   215.59  *
*   426      77.50 -  78.00     37.50 - 38.00      3.854    .091    64.60      3.511    .244   209.43  *
*   427      77.50 -  78.00     38.00 - 38.50      3.854    .091   102.18      3.302    .259   208.86  *
*   428      77.50 -  78.00     38.50 - 39.00      3.910    .120   106.15      3.549    .245   210.76  *
*   429      77.50 -  78.00     39.00 - 39.50      3.927    .103    94.40      3.546    .245   199.97  *
*   430      77.50 -  78.00     39.50 - 40.00      3.924    .106   148.97      3.546    .245   179.78  *
*   431      77.50 -  78.00     40.00 - 40.50      2.985    .096    83.49      2.521    .367    53.60  *
*   432      77.50 -  78.00     40.50 - 41.00      2.781    .122    95.53      2.521    .367    63.75  *
*   433      77.50 -  78.00     41.00 - 41.50      3.043    .340   121.05      2.881    .298    97.93  *
*   434      77.50 -  78.00     41.50 - 42.00      3.042    .278    93.31      2.881    .298    88.05  *
*   435      77.50 -  78.00     42.00 - 42.50      3.068    .281    64.23      2.621    .255    43.95  *
*   436      77.50 -  78.00     42.50 - 43.00      3.009    .313    39.26      2.621    .255    27.24  *
*   437      77.50 -  78.00     43.00 - 43.50      3.027    .294    56.08      2.621    .255    43.95  *
*   438      77.50 -  78.00     43.50 - 44.00      3.131    .271    86.81      2.621    .255    74.18  *
*   439      77.50 -  78.00     44.00 - 44.50      3.131    .271   104.48      2.621    .255   107.02  *
*   440      77.50 -  78.00     44.50 - 45.00      2.848    .171    87.73      2.071    .000   103.98  *
*   441      78.00 -  78.50     31.00 - 31.50      3.631    .415   171.39      2.680    .206   176.02  *
*   442      78.00 -  78.50     31.50 - 32.00      3.665    .399   156.45      2.680    .206   153.96  *
*   443      78.00 -  78.50     32.00 - 32.50      3.669    .395   141.81      2.680    .206   135.63  *
*   444      78.00 -  78.50     32.50 - 33.00      3.684    .388   136.48      2.922    .255   162.16  *
*   445      78.00 -  78.50     33.00 - 33.50      3.818    .309   160.10      3.477    .233   247.02  *
*   446      78.00 -  78.50     33.50 - 34.00      3.860    .280   161.26      3.477    .233   240.65  *
*   447      78.00 -  78.50     34.00 - 34.50      3.853    .284   105.69      3.477    .233   238.51  *
*   448      78.00 -  78.50     34.50 - 35.00      3.867    .276   174.87      3.477    .233   235.90  *
*   449      78.00 -  78.50     35.00 - 35.50      3.887    .266   191.30      3.477    .233   230.96  *
*   450      78.00 -  78.50     35.50 - 36.00      3.905    .253   191.47      3.520    .232   230.88  *
*   451      78.00 -  78.50     36.00 - 36.50      3.908    .259   179.09      3.557    .233   226.49  *
*   452      78.00 -  78.50     36.50 - 37.00      3.938    .251   155.81      3.576    .218   222.87  *
*   453      78.00 -  78.50     37.00 - 37.50      3.758    .142    92.38      3.574    .218   219.93  *
*   454      78.00 -  78.50     37.50 - 38.00      3.760    .133    43.71      3.511    .244   211.39  *
*   455      78.00 -  78.50     38.00 - 38.50      3.777    .149    79.85      3.502    .259   211.81  *
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                        * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    Q(H)    R(H)       A(N)    Q(N)    R(N)

   456    78.00 -  78.50    38.50 - 39.00     3.860   .111     51.98     3.549   .245   215.81
   457    78.00 -  78.50    39.00 - 39.50     3.877   .097     84.59     3.549   .245   211.11
   458    78.00 -  78.50    39.50 - 40.00     3.874   .099    140.76     3.549   .245   203.23
   459    78.00 -  78.50    40.00 - 40.50     2.782   .112     82.12     2.521   .367    79.63
   460    78.00 -  78.50    40.50 - 41.00     2.432   .000    102.99     2.521   .367    86.78
   461    78.00 -  78.50    41.00 - 41.50     2.742   .497    104.80     2.881   .298   105.53
   462    78.00 -  78.50    41.50 - 42.00     2.975   .318     86.06     2.881   .298    86.54
   463    78.00 -  78.50    42.00 - 42.50     2.954   .343     47.25     2.621   .255    35.92
   464    78.00 -  78.50    42.50 - 43.00     2.954   .343     14.28     2.621   .255    10.00
   465    78.00 -  78.50    43.00 - 43.50     2.954   .343     38.46     2.621   .255    35.92
   466    78.00 -  78.50    43.50 - 44.00     3.068   .326     73.70     2.621   .255    69.72
   467    78.00 -  78.50    44.00 - 44.50     3.068   .326    102.50     2.621   .255   103.98
   468    78.00 -  78.50    44.50 - 45.00     2.739   .217     98.42     2.071   .000   106.68
   469    78.50 -  79.00    31.00 - 31.50     3.635   .410    150.65     2.829   .122   179.04
   470    78.50 -  79.00    31.50 - 32.00     3.669   .395    131.75     2.829   .122   153.47
   471    78.50 -  79.00    32.00 - 32.50     3.673   .392    113.55     2.829   .122   130.69
   472    78.50 -  79.00    32.50 - 33.00     3.687   .385    106.77     3.013   .205   143.44
   473    78.50 -  79.00    33.00 - 33.50     3.821   .304    130.60     3.500   .214   215.14
   474    78.50 -  79.00    33.50 - 34.00     3.863   .277    144.63     3.500   .214   215.24
   475    78.50 -  79.00    34.00 - 34.50     3.855   .281    148.55     3.500   .214   222.09
   476    78.50 -  79.00    34.50 - 35.00     3.870   .273    167.97     3.500   .214   226.68
   477    78.50 -  79.00    35.00 - 35.50     3.889   .263    179.37     3.500   .214   226.11
   478    78.50 -  79.00    35.50 - 36.00     3.907   .260    179.94     3.541   .215   227.17
   479    78.50 -  79.00    36.00 - 36.50     3.910   .257    169.06     3.576   .218   223.06
   480    78.50 -  79.00    36.50 - 37.00     3.960   .246    153.64     3.576   .218   215.97
   481    78.50 -  79.00    37.00 - 37.50     3.795   .161     94.76     3.576   .218   212.69
   482    78.50 -  79.00    37.50 - 38.00     3.795   .154     42.66     3.511   .244   205.66
   483    78.50 -  79.00    38.00 - 38.50     3.802   .166     86.47     3.502   .259   208.73
   484    78.50 -  79.00    38.50 - 39.00     3.883   .120    102.38     3.549   .245   216.62
   485    78.50 -  79.00    39.00 - 39.50     3.900   .107    124.70     3.549   .245   217.38
   486    78.50 -  79.00    39.50 - 40.00     3.897   .108    153.26     3.549   .245   216.72
   487    78.50 -  79.00    40.00 - 40.50     2.744   .149     87.81     2.521   .367   105.80
   488    78.50 -  79.00    40.50 - 41.00     2.531   .061    105.31     2.521   .367   111.28
   489    78.50 -  79.00    41.00 - 41.50     2.874   .410    113.34     2.881   .298   115.60
   490    78.50 -  79.00    41.50 - 42.00     3.025   .309     86.90     2.881   .298    93.37
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*                            * SEISMIC MAP OF CONTINENTAL U.S. *                         *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)   B(H)    R(H)       A(N)   B(N)    R(N)  *
******************************************************************************************
*                                                                                        *
*   491    78.50 - 79.00    42.00 - 42.50      3.025   .309    56.72      2.621   .255    43.95  *
*   492    78.50 - 79.00    42.50 - 43.00      3.025   .309    35.81      2.621   .255    27.24  *
*   493    78.50 - 79.00    43.00 - 43.50      3.025   .309    26.73      2.621   .255    43.95  *
*   494    78.50 - 79.00    43.50 - 44.00      3.128   .286    70.08      2.621   .255    74.18  *
*   495    78.50 - 79.00    44.00 - 44.50      3.068   .326   100.91      2.621   .255   107.02  *
*   496    78.50 - 79.00    44.50 - 45.00      2.739   .217   105.02      2.071   .000   114.41  *
*   497    79.00 - 79.50    25.00 - 25.50      2.688   .671   197.40       .000   .000      .00  *
*   498    79.00 - 79.50    25.50 - 26.00      2.906   .485   273.28       .000   .000      .00  *
*   499    79.00 - 79.50    26.00 - 26.50      2.960   .414   298.07       .000   .000      .00  *
*   500    79.00 - 79.50    26.50 - 27.00      2.960   .414   309.39       .000   .000      .00  *
*   501    79.00 - 79.50    27.00 - 27.50      2.478   .149   241.67       .000   .000      .00  *
*   502    79.00 - 79.50    27.50 - 28.00      2.478   .149   218.59       .000   .000      .00  *
*   503    79.00 - 79.50    28.00 - 28.50      2.779   .149   235.95       .000   .000      .00  *
*   504    79.00 - 79.50    28.50 - 29.00      3.527   .478   264.56       .000   .000      .00  *
*   505    79.00 - 79.50    29.00 - 29.50      3.555   .456   235.66      2.780   .175   289.08  *
*   506    79.00 - 79.50    29.50 - 30.00      3.587   .439   210.74      2.822   .122   251.61  *
*   507    79.00 - 79.50    30.00 - 30.50      3.593   .433   183.09      2.822   .122   222.20  *
*   508    79.00 - 79.50    30.50 - 31.00      3.626   .420   160.92      2.822   .122   192.98  *
*   509    79.00 - 79.50    31.00 - 31.50      3.648   .405   134.50      2.822   .122   164.00  *
*   510    79.00 - 79.50    31.50 - 32.00      3.684   .388   110.76      2.822   .122   135.48  *
*   511    79.00 - 79.50    32.00 - 32.50      3.708   .382    88.83      2.822   .122   108.31  *
*   512    79.00 - 79.50    32.50 - 33.00      3.729   .374    79.01      2.822   .122    85.59  *
*   513    79.00 - 79.50    33.00 - 33.50      3.855   .287   103.07      3.187   .085   116.88  *
*   514    79.00 - 79.50    33.50 - 34.00      3.891   .266   128.22      3.187   .085   126.61  *
*   515    79.00 - 79.50    34.00 - 34.50      3.885   .269   147.15      3.187   .085   146.25  *
*   516    79.00 - 79.50    34.50 - 35.00      3.899   .261   162.05      3.187   .085   161.14  *
*   517    79.00 - 79.50    35.00 - 35.50      3.916   .253   169.66      3.187   .085   167.03  *
*   518    79.00 - 79.50    35.50 - 36.00      3.932   .252   169.71      3.286   .137   181.59  *
*   519    79.00 - 79.50    36.00 - 36.50      3.935   .249   160.40      3.363   .173   184.96  *
*   520    79.00 - 79.50    36.50 - 37.00      4.052   .230   160.92      3.574   .218   201.16  *
*   521    79.00 - 79.50    37.00 - 37.50      3.961   .159   126.02      3.574   .218   196.37  *
*   522    79.00 - 79.50    37.50 - 38.00      3.962   .151   106.14      3.511   .244   191.43  *
*   523    79.00 - 79.50    38.00 - 38.50      3.966   .162   123.91      3.502   .259   199.05  *
*   524    79.00 - 79.50    38.50 - 39.00      4.015   .162   147.67      3.549   .245   212.32  *
*   525    79.00 - 79.50    39.00 - 39.50      4.018   .144   162.25      3.549   .245   217.91  *
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                         * SEISMIC MAP OF CONTINENTAL U.S. *

   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

   526     79.00 -  79.50     39.50 - 40.00      4.011   .153   177.83       3.549   .245   222.10
   527     79.00 -  79.50     40.00 - 40.50      2.793   .101    97.52        .000   .000      .00
   528     79.00 -  79.50     40.50 - 41.00      2.594   .001    95.75        .000   .000      .00
   529     79.00 -  79.50     41.00 - 41.50      2.914   .362   107.39       2.621   .255   115.67
   530     79.00 -  79.50     41.50 - 42.00      3.047   .283    87.50       2.621   .255    86.19
   531     79.00 -  79.50     42.00 - 42.50      3.047   .283    67.05       2.621   .255    62.11
   532     79.00 -  79.50     42.50 - 43.00      3.047   .283    50.98       2.621   .255    51.65
   533     79.00 -  79.50     43.00 - 43.50      3.025   .309    32.16       2.621   .255    62.11
   534     79.00 -  79.50     43.50 - 44.00      3.025   .309    62.35       2.621   .255    86.19
   535     79.00 -  79.50     44.00 - 44.50      2.954   .343    93.98       2.621   .255   115.67
   536     79.00 -  79.50     44.50 - 45.00      2.557   .212   104.94       2.071   .000   126.23
   537     79.00 -  79.50     45.00 - 45.50      2.592   .671   103.98       2.071   .000    99.92
   538     79.00 -  79.50     45.50 - 46.00      2.592   .671    69.72       2.071   .000    80.08
   539     79.00 -  79.50     46.00 - 46.50      2.592   .671    35.92       2.071   .000    72.27
   540     79.00 -  79.50     46.50 - 47.00      2.592   .671    10.00       2.071   .000    80.08
   541     79.50 -  80.00     25.00 - 25.50      2.688   .671   184.13        .000   .000      .00
   542     79.50 -  80.00     25.50 - 26.00      2.906   .485   259.83        .000   .000      .00
   543     79.50 -  80.00     26.00 - 26.50      2.960   .414   285.34        .000   .000      .00
   544     79.50 -  80.00     26.50 - 27.00      2.960   .414   295.80        .000   .000      .00
   545     79.50 -  80.00     27.00 - 27.50      2.478   .149   223.16        .000   .000      .00
   546     79.50 -  80.00     27.50 - 28.00      2.478   .149   198.00        .000   .000      .00
   547     79.50 -  80.00     28.00 - 28.50      2.779   .149   214.90        .000   .000      .00
   548     79.50 -  80.00     28.50 - 29.00      3.527   .478   253.75        .000   .000      .00
   549     79.50 -  80.00     29.00 - 29.50      3.555   .456   224.67       2.780   .175   281.64
   550     79.50 -  80.00     29.50 - 30.00      3.587   .439   199.65       2.822   .122   243.52
   551     79.50 -  80.00     30.00 - 30.50      3.593   .433   172.42       2.822   .122   213.35
   552     79.50 -  80.00     30.50 - 31.00      3.626   .420   149.68       2.822   .122   183.16
   553     79.50 -  80.00     31.00 - 31.50      3.656   .397   122.31       2.822   .122   152.79
   554     79.50 -  80.00     31.50 - 32.00      3.694   .379    94.15       2.822   .122   122.01
   555     79.50 -  80.00     32.00 - 32.50      3.729   .370    63.91       2.822   .122    90.72
   556     79.50 -  80.00     32.50 - 33.00      3.747   .365    44.66       2.822   .122    60.16
   557     79.50 -  80.00     33.00 - 33.50      3.872   .270    72.75       3.187   .085    69.22
   558     79.50 -  80.00     33.50 - 34.00      3.905   .254   110.06       3.187   .085    93.41
   559     79.50 -  80.00     34.00 - 34.50      3.899   .256   136.43       3.187   .085   126.01
   560     79.50 -  80.00     34.50 - 35.00      3.912   .250   151.53       3.187   .085   146.26
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***************************************************************************************************
*                         * SEISMIC MAP OF CONTINENTAL U.S. *                                      *
***************************************************************************************************
*   GFID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)       A(N)    C(N)    R(N)  *
***************************************************************************************************
*                                                                                                  *
*    561    79.50 -  80.00    35.00 - 35.50       3.929   .244   157.28      3.187   .085   153.02  *
*    562    79.50 -  80.00    35.50 - 36.00       3.944   .243   157.36      3.286   .137   164.35  *
*    563    79.50 -  80.00    36.00 - 36.50       3.974   .245   151.87      3.363   .173   163.03  *
*    564    79.50 -  80.00    36.50 - 37.00       4.042   .225   146.73      3.363   .173   146.11  *
*    565    79.50 -  80.00    37.00 - 37.50       3.941   .144   119.74      3.363   .173   137.44  *
*    566    79.50 -  80.00    37.50 - 38.00       3.938   .139   120.59      3.231   .173   126.06  *
*    567    79.50 -  80.00    38.00 - 38.50       3.943   .151   133.41      3.214   .194   138.18  *
*    568    79.50 -  80.00    38.50 - 39.00       3.991   .158   155.91      3.314   .205   165.63  *
*    569    79.50 -  80.00    39.00 - 39.50       3.993   .142   167.49      3.314   .205   173.85  *
*    570    79.50 -  80.00    39.50 - 40.00       3.986   .153   177.40      3.314   .205   179.57  *
*    571    79.50 -  80.00    40.00 - 40.50       2.895   .001   100.49       .000   .000      .00  *
*    572    79.50 -  80.00    40.50 - 41.00       2.715   .123    73.96       .000   .000      .00  *
*    573    79.50 -  80.00    41.00 - 41.50       2.985   .296    90.08      2.621   .255   128.80  *
*    574    79.50 -  80.00    41.50 - 42.00       3.094   .239    79.28      2.621   .255   103.14  *
*    575    79.50 -  80.00    42.00 - 42.50       3.094   .239    67.61      2.621   .255    84.06  *
*    576    79.50 -  80.00    42.50 - 43.00       3.094   .239    58.39      2.621   .255    76.66  *
*    577    79.50 -  80.00    43.00 - 43.50       3.065   .264    30.42      2.621   .255    84.06  *
*    578    79.50 -  80.00    43.50 - 44.00       3.025   .309    67.22      2.621   .255   103.14  *
*    579    79.50 -  80.00    44.00 - 44.50       2.954   .343   100.41      2.621   .255   128.80  *
*    580    79.50 -  80.00    44.50 - 45.00       2.557   .212   107.41      2.071   .000   141.13  *
*    581    79.50 -  80.00    45.00 - 45.50       2.592   .671   106.63      2.071   .000   118.18  *
*    582    79.50 -  80.00    45.50 - 46.00       2.592   .671    73.62      2.071   .000   101.96  *
*    583    79.50 -  80.00    46.00 - 46.50       2.592   .671    43.00      2.071   .000    95.95  *
*    584    79.50 -  80.00    46.50 - 47.00       2.592   .671    25.67      2.071   .000   101.96  *
*    585    80.00 -  80.50    25.00 - 25.50       2.688   .671   175.69       .000   .000      .00  *
*    586    80.00 -  80.50    25.50 - 26.00       2.906   .485   250.84       .000   .000      .00  *
*    587    80.00 -  80.50    26.00 - 26.50       2.960   .414   276.17       .000   .000      .00  *
*    588    80.00 -  80.50    26.50 - 27.00       2.960   .414   285.14       .000   .000      .00  *
*    589    80.00 -  80.50    27.00 - 27.50       2.478   .149   206.91       .000   .000      .00  *
*    590    80.00 -  80.50    27.50 - 28.00       2.478   .149   179.55       .000   .000      .00  *
*    591    80.00 -  80.50    28.00 - 28.50       2.779   .149   194.97       .000   .000      .00  *
*    592    80.00 -  80.50    28.50 - 29.00       3.527   .478   243.50       .000   .000      .00  *
*    593    80.00 -  80.50    29.00 - 29.50       3.555   .456   213.95      2.780   .175   276.58  *
*    594    80.00 -  80.50    29.50 - 30.00       3.587   .439   189.17      2.822   .122   237.94  *
*    595    80.00 -  80.50    30.00 - 30.50       3.593   .433   163.68      2.822   .122   207.42  *
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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                           *
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*  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    Q(H)    R(H)      A(N)   Q(N)    R(N)  *
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*
*   596    80.00 -  80.50    30.50 - 31.00      3.626   .420   142.45     2.822   .122   176.85  *
*   597    80.00 -  80.50    31.00 - 31.50      3.656   .397   115.31     2.822   .122   145.98  *
*   598    80.00 -  80.50    31.50 - 32.00      3.697   .377    85.87     2.822   .122   114.44  *
*   599    80.00 -  80.50    32.00 - 32.50      3.731   .368    50.32     2.822   .122    81.47  *
*   600    80.00 -  80.50    32.50 - 33.00      3.750   .363    15.37     2.822   .122    46.16  *
*   601    80.00 -  80.50    33.00 - 33.50      3.874   .268    48.16     3.187   .085    25.14  *
*   602    80.00 -  80.50    33.50 - 34.00      3.907   .252   100.01     3.187   .085    73.20  *
*   603    80.00 -  80.50    34.00 - 34.50      3.901   .254   128.65     3.187   .085   113.47  *
*   604    80.00 -  80.50    34.50 - 35.00      3.914   .248   140.56     3.187   .085   135.86  *
*   605    80.00 -  80.50    35.00 - 35.50      3.930   .242   139.69     3.187   .085   142.22  *
*   606    80.00 -  80.50    35.50 - 36.00      3.945   .242   143.84     3.284   .137   149.70  *
*   607    80.00 -  80.50    36.00 - 36.50      3.974   .245   137.83     3.363   .173   142.21  *
*   608    80.00 -  80.50    36.50 - 37.00      4.042   .221   124.01     3.363   .173   115.74  *
*   609    80.00 -  80.50    37.00 - 37.50      3.998   .136    95.49     3.363   .173    96.85  *
*   610    80.00 -  80.50    37.50 - 38.00      3.995   .132   119.67     3.239   .173    98.40  *
*   611    80.00 -  80.50    38.00 - 38.50      4.007   .143   147.26     3.214   .194   118.95  *
*   612    80.00 -  80.50    38.50 - 39.00      4.055   .148   173.25     3.314   .205   150.98  *
*   613    80.00 -  80.50    39.00 - 39.50      4.055   .135   182.94     3.314   .205   161.54  *
*   614    80.00 -  80.50    39.50 - 40.00      4.044   .151   189.20     3.314   .205   169.01  *
*   615    80.00 -  80.50    40.00 - 40.50      4.021   .163   189.77     3.314   .205   178.02  *
*   616    80.00 -  80.50    40.50 - 41.00      4.002   .166   184.74     3.314   .205   188.22  *
*   617    80.00 -  80.50    41.00 - 41.50      4.007   .185   179.77     3.314   .205   195.80  *
*   618    80.00 -  80.50    41.50 - 42.00      3.928   .162   155.12     3.040   .318   156.51  *
*   619    80.00 -  80.50    42.00 - 42.50      3.883   .177   131.71     3.072   .282   155.13  *
*   620    80.00 -  80.50    42.50 - 43.00      3.936   .203   158.44     3.072   .282   154.52  *
*   621    80.00 -  80.50    43.00 - 43.50      3.985   .242   168.83     3.121   .234   169.47  *
*   622    80.00 -  80.50    43.50 - 44.00      3.961   .255   201.11     3.121   .234   186.49  *
*   623    80.00 -  80.50    44.00 - 44.50      3.936   .259   231.40     2.981   .206   182.06  *
*   624    80.00 -  80.50    44.50 - 45.00      3.875   .270   244.85     2.754   .184   154.43  *
*   625    80.00 -  80.50    45.00 - 45.50      3.733   .252   231.12     2.754   .184   161.56  *
*   626    80.00 -  80.50    45.50 - 46.00      3.721   .269   227.84     2.754   .184   165.57  *
*   627    80.00 -  80.50    46.00 - 46.50      3.700   .301   204.17     2.754   .184   170.08  *
*   628    80.00 -  80.50    46.50 - 47.00      3.599   .351   169.04     2.754   .184   178.50  *
*   629    80.50 -  81.00    25.00 - 25.50      2.688   .671   172.79      .000   .000      .00  *
*   630    80.50 -  81.00    25.50 - 26.00      2.906   .485   246.72      .000   .000      .00  *
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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                              *
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*   GRID     LONG1 - LONG2      LAT1 - LAT2       A(H)    C(H)    R(H)      A(N)   C(N)    R(N)   *
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*                                                                                           *
*   631     80.50 -  81.00    26.00 - 26.50      2.960   .414   270.80     .000   .000     .00   *
*   632     80.50 -  81.00    26.50 - 27.00      2.960   .414   277.64     .000   .000     .00   *
*   633     80.50 -  81.00    27.00 - 27.50      2.478   .149   193.47     .000   .000     .00   *
*   634     80.50 -  81.00    27.50 - 28.00      2.478   .149   163.92     .000   .000     .00   *
*   635     80.50 -  81.00    28.00 - 28.50      2.779   .149   176.84     .000   .000     .00   *
*   636     80.50 -  81.00    28.50 - 29.00      3.527   .478   233.09     .000   .000     .00   *
*   637     80.50 -  81.00    29.00 - 29.50      3.555   .456   201.68    2.780   .175  273.87   *
*   638     80.50 -  81.00    29.50 - 30.00      3.587   .439   176.40    2.822   .122  234.87   *
*   639     80.50 -  81.00    30.00 - 30.50      3.593   .433   154.07    2.822   .122  204.35   *
*   640     80.50 -  81.00    30.50 - 31.00      3.626   .420   138.29    2.822   .122  173.94   *
*   641     80.50 -  81.00    31.00 - 31.50      3.663   .391   114.97    2.822   .122  143.55   *
*   642     80.50 -  81.00    31.50 - 32.00      3.702   .373    86.70    2.822   .122  112.99   *
*   643     80.50 -  81.00    32.00 - 32.50      3.739   .363    58.89    2.822   .122   81.89   *
*   644     80.50 -  81.00    32.50 - 33.00      3.756   .359    43.89    2.822   .122   50.30   *
*   645     80.50 -  81.00    33.00 - 33.50      3.880   .260    71.40    3.187   .085   38.05   *
*   646     80.50 -  81.00    33.50 - 34.00      3.912   .246   105.60    3.187   .085   76.78   *
*   647     80.50 -  81.00    34.00 - 34.50      3.906   .248   125.32    3.187   .085  109.19   *
*   648     80.50 -  81.00    34.50 - 35.00      3.917   .244   129.60    3.187   .085  129.85   *
*   649     80.50 -  81.00    35.00 - 35.50      3.933   .239    98.17    3.187   .085  134.82   *
*   650     80.50 -  81.00    35.50 - 36.00      3.938   .238   129.21    3.286   .137  138.49   *
*   651     80.50 -  81.00    36.00 - 36.50      3.969   .239   121.21    3.363   .173  124.94   *
*   652     80.50 -  81.00    36.50 - 37.00      4.049   .220   104.22    3.363   .173   89.53   *
*   653     80.50 -  81.00    37.00 - 37.50      4.010   .137    41.97    3.363   .173   47.36   *
*   654     80.50 -  81.00    37.50 - 38.00      4.007   .132   106.52    3.231   .173   75.20   *
*   655     80.50 -  81.00    38.00 - 38.50      4.025   .142   146.61    3.214   .194  102.92   *
*   656     80.50 -  81.00    38.50 - 39.00      4.072   .142   172.33    3.314   .205  137.26   *
*   657     80.50 -  81.00    39.00 - 39.50      4.072   .130   178.37    3.314   .205  146.34   *
*   658     80.50 -  81.00    39.50 - 40.00      4.061   .146   181.51    3.314   .205  151.80   *
*   659     80.50 -  81.00    40.00 - 40.50      4.040   .157   180.62    3.314   .205  164.37   *
*   660     80.50 -  81.00    40.50 - 41.00      4.016   .163   169.89    3.314   .205  182.29   *
*   661     80.50 -  81.00    41.00 - 41.50      4.010   .176   153.19    3.314   .205  198.29   *
*   662     80.50 -  81.00    41.50 - 42.00      3.930   .155   134.70    3.040   .318  169.19   *
*   663     80.50 -  81.00    42.00 - 42.50      3.887   .168    74.17    3.072   .282  175.14   *
*   664     80.50 -  81.00    42.50 - 43.00      3.922   .205   153.26    3.072   .282  178.89   *
*   665     80.50 -  81.00    43.00 - 43.50      3.921   .219   182.21    3.098   .255  191.31   *
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *                   *
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*  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)   C(H)   R(H)       A(N)   C(N)    R(N)  *
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*
*  666     80.50 -  81.00     43.50 - 44.00      3.895   .232  204.60     3.098   .255  206.10  *
*  667     80.50 -  81.00     44.00 - 44.50      3.867   .235  227.18     2.954   .225  200.92  *
*  668     80.50 -  81.00     44.50 - 45.00      3.796   .243  238.53     2.722   .187  170.45  *
*  669     80.50 -  81.00     45.00 - 45.50      3.631   .200  223.30     2.722   .187  179.33  *
*  670     80.50 -  81.00     45.50 - 46.00      3.618   .220  226.81     2.722   .187  186.28  *
*  671     80.50 -  81.00     46.00 - 46.50      3.595   .257  219.54     2.722   .187  193.56  *
*  672     80.50 -  81.00     46.50 - 47.00      3.472   .308  196.42     2.722   .187  203.60  *
*  673     81.00 -  81.50     25.00 - 25.50      2.688   .671  175.69      .000   .000     .00  *
*  674     81.00 -  81.50     25.50 - 26.00      2.906   .485  247.58      .000   .000     .00  *
*  675     81.00 -  81.50     26.00 - 26.50      2.960   .414  269.33      .000   .000     .00  *
*  676     81.00 -  81.50     26.50 - 27.00      2.960   .414  273.57      .000   .000     .00  *
*  677     81.00 -  81.50     27.00 - 27.50      2.478   .149  183.46      .000   .000     .00  *
*  678     81.00 -  81.50     27.50 - 28.00      2.478   .149  151.93      .000   .000     .00  *
*  679     81.00 -  81.50     28.00 - 28.50      2.779   .149  161.76      .000   .000     .00  *
*  680     81.00 -  81.50     28.50 - 29.00      3.527   .478  222.21      .000   .000     .00  *
*  681     81.00 -  81.50     29.00 - 29.50      3.555   .456  185.21     2.780   .175  273.44  *
*  682     81.00 -  81.50     29.50 - 30.00      3.587   .439  155.43     2.822   .122  234.19  *
*  683     81.00 -  81.50     30.00 - 30.50      3.593   .433  133.24     2.822   .122  203.94  *
*  684     81.00 -  81.50     30.50 - 31.00      3.626   .420  134.54     2.822   .122  174.05  *
*  685     81.00 -  81.50     31.00 - 31.50      3.663   .391  119.13     2.822   .122  144.69  *
*  686     81.00 -  81.50     31.50 - 32.00      3.702   .373   91.82     2.822   .122  116.11  *
*  687     81.00 -  81.50     32.00 - 32.50      3.739   .363   47.75     2.822   .122   88.79  *
*  688     81.00 -  81.50     32.50 - 33.00      3.756   .359   71.51     2.822   .122   64.03  *
*  689     81.00 -  81.50     33.00 - 33.50      3.880   .260   96.79     3.187   .085   77.78  *
*  690     81.00 -  81.50     33.50 - 34.00      3.912   .246  116.34     3.187   .085   80.48  *
*  691     81.00 -  81.50     34.00 - 34.50      3.917   .244  123.42     3.187   .085  105.74  *
*  692     81.00 -  81.50     34.50 - 35.00      3.928   .242  116.81     3.187   .085  127.07  *
*  693     81.00 -  81.50     35.00 - 35.50      3.943   .237  121.12     3.187   .085  130.89  *
*  694     81.00 -  81.50     35.50 - 36.00      3.948   .236  122.04     3.286   .137  131.63  *
*  695     81.00 -  81.50     36.00 - 36.50      3.977   .239   92.52     3.363   .173  113.69  *
*  696     81.00 -  81.50     36.50 - 37.00      4.051   .226   90.08     3.363   .173   73.75  *
*  697     81.00 -  81.50     37.00 - 37.50      4.013   .152   66.22     3.363   .173   34.92  *
*  698     81.00 -  81.50     37.50 - 38.00      4.010   .147  114.68     3.231   .173   61.52  *
*  699     81.00 -  81.50     38.00 - 38.50      4.017   .146  145.89     3.214   .194   92.33  *
*  700     81.00 -  81.50     38.50 - 39.00      4.054   .143  163.34     3.314   .205  126.12  *
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                          * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2    LAT1 - LAT2        A(H)    O(H)    R(H)        A(N)    B(N)    R(N)

   701   81.00 - 81.50    39.00 - 39.50      4.054   .130   162.08       3.314   .205   127.49
   702   81.00 - 81.50    39.50 - 40.00      4.037   .149   161.89       3.314   .205   124.19
   703   81.00 - 81.50    40.00 - 40.50      4.014   .162   162.88       3.314   .205   142.62
   704   81.00 - 81.50    40.50 - 41.00      3.986   .173   148.87       3.314   .205   172.43
   705   81.00 - 81.50    41.00 - 41.50      3.979   .189    97.47       3.314   .205   198.31
   706   81.00 - 81.50    41.50 - 42.00      3.896   .159   110.71       3.040   .318   178.92
   707   81.00 - 81.50    42.00 - 42.50      3.847   .179   114.05       3.072   .282   191.62
   708   81.00 - 81.50    42.50 - 43.00      3.882   .224   153.88       3.072   .282   199.46
   709   81.00 - 81.50    43.00 - 43.50      3.894   .229   186.22       3.098   .255   212.70
   710   81.00 - 81.50    43.50 - 44.00      3.866   .244   208.50       3.098   .255   226.18
   711   81.00 - 81.50    44.00 - 44.50      3.835   .249   228.44       2.954   .225   221.31
   712   81.00 - 81.50    44.50 - 45.00      3.761   .255   240.13       2.722   .187   186.81
   713   81.00 - 81.50    45.00 - 45.50      3.577   .216   225.64       2.722   .187   195.60
   714   81.00 - 81.50    45.50 - 46.00      3.562   .237   235.55       2.722   .187   203.57
   715   81.00 - 81.50    46.00 - 46.50      3.535   .278   239.37       2.722   .187   212.04
   716   81.00 - 81.50    46.50 - 47.00      3.383   .346   220.71       2.722   .187   222.55
   717   81.50 - 82.00    25.00 - 25.50      2.688   .671   184.13        .000   .000      .00
   718   81.50 - 82.00    25.50 - 26.00      2.906   .485   253.14        .000   .000      .00
   719   81.50 - 82.00    26.00 - 26.50      2.960   .414   271.69        .000   .000      .00
   720   81.50 - 82.00    26.50 - 27.00      2.960   .414   273.17        .000   .000      .00
   721   81.50 - 82.00    27.00 - 27.50      2.478   .149   177.51        .000   .000      .00
   722   81.50 - 82.00    27.50 - 28.00      2.478   .149   144.57        .000   .000      .00
   723   81.50 - 82.00    28.00 - 28.50      2.779   .149   151.74        .000   .000      .00
   724   81.50 - 82.00    28.50 - 29.00      3.527   .478   212.70        .000   .000      .00
   725   81.50 - 82.00    29.00 - 29.50      3.555   .456   162.36       2.780   .175   275.17
   726   81.50 - 82.00    29.50 - 30.00      3.620   .426   125.57       2.822   .122   235.74
   727   81.50 - 82.00    30.00 - 30.50      3.652   .413    82.58       2.822   .122   205.88
   728   81.50 - 82.00    30.50 - 31.00      3.673   .410   139.62       2.822   .122   176.60
   729   81.50 - 82.00    31.00 - 31.50      3.708   .382   135.10       2.822   .122   148.21
   730   81.50 - 82.00    31.50 - 32.00      3.740   .370   113.72       2.822   .122   121.30
   731   81.50 - 82.00    32.00 - 32.50      3.771   .363    94.87       2.822   .122    96.89
   732   81.50 - 82.00    32.50 - 33.00      3.787   .359    98.03       2.822   .122    76.53
   733   81.50 - 82.00    33.00 - 33.50      3.905   .258   119.13       3.187   .085    93.15
   734   81.50 - 82.00    33.50 - 34.00      3.934   .246   126.47       3.187   .085    44.93
   735   81.50 - 82.00    34.00 - 34.50      3.939   .245   121.89       3.187   .085   102.01
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*****************************************************************************************
*                          * SEISMIC MAP OF CONTINENTAL U.S. *                          *
*****************************************************************************************
*  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)   C(H)    R(H)       A(N)   C(N)    R(N)   *
*****************************************************************************************
*                                                                                       *
*   736     81.50 -  82.00     34.50 - 35.00      3.949  .242    73.77      3.187  .085   127.66  *
*   737     81.50 -  82.00     35.00 - 35.50      3.962  .239   115.36      3.187  .085   130.65  *
*   738     81.50 -  82.00     35.50 - 36.00      3.967  .238   114.94      3.284  .137   129.89  *
*   739     81.50 -  82.00     36.00 - 36.50      3.992  .244   113.73      3.284  .137    99.63  *
*   740     81.50 -  82.00     36.50 - 37.00      4.051  .225   112.37      3.369  .173    67.26  *
*   741     81.50 -  82.00     37.00 - 37.50      4.013  .151   111.40      3.363  .173    25.78  *
*   742     81.50 -  82.00     37.50 - 38.00      4.011  .147   131.40      3.234  .173    55.92  *
*   743     81.50 -  82.00     38.00 - 38.50      4.017  .146   147.66      3.214  .194    88.45  *
*   744     81.50 -  82.00     38.50 - 39.00      4.054  .142   152.09      3.314  .205   119.21  *
*   745     81.50 -  82.00     39.00 - 39.50      4.054  .129   132.98      3.314  .205   105.00  *
*   746     81.50 -  82.00     39.50 - 40.00      4.038  .148   132.55      3.314  .205    79.20  *
*   747     81.50 -  82.00     40.00 - 40.50      4.014  .161   146.33      3.314  .205   114.56  *
*   748     81.50 -  82.00     40.50 - 41.00      3.987  .172   139.40      3.314  .205   162.21  *
*   749     81.50 -  82.00     41.00 - 41.50      3.980  .188    92.68      3.314  .205   198.14  *
*   750     81.50 -  82.00     41.50 - 42.00      3.897  .158    68.24      3.040  .318   187.04  *
*   751     81.50 -  82.00     42.00 - 42.50      3.848  .177   119.45      3.072  .282   205.75  *
*   752     81.50 -  82.00     42.50 - 43.00      3.883  .222   158.61      3.072  .282   217.37  *
*   753     81.50 -  82.00     43.00 - 43.50      3.858  .240   182.38      3.098  .255   231.97  *
*   754     81.50 -  82.00     43.50 - 44.00      3.821  .265   202.92      3.098  .255   245.20  *
*   755     81.50 -  82.00     44.00 - 44.50      3.806  .275   226.26      2.954  .225   242.42  *
*   756     81.50 -  82.00     44.50 - 45.00      3.726  .285   238.57      2.722  .187   204.21  *
*   757     81.50 -  82.00     45.00 - 45.50      3.555  .233   232.60      2.722  .187   212.64  *
*   758     81.50 -  82.00     45.50 - 46.00      3.538  .257   247.81      2.722  .187   221.04  *
*   759     81.50 -  82.00     46.00 - 46.50      3.507  .303   259.59      2.722  .187   230.16  *
*   760     81.50 -  82.00     46.50 - 47.00      3.332  .390   245.10      2.722  .187   240.99  *
*   761     82.00 -  82.50     25.00 - 25.50      2.688  .671   197.40       .000  .000      .00  *
*   762     82.00 -  82.50     25.50 - 26.00      2.906  .485   262.86       .000  .000      .00  *
*   763     82.00 -  82.50     26.00 - 26.50      2.960  .414   277.71       .000  .000      .00  *
*   764     82.00 -  82.50     26.50 - 27.00      2.960  .414   276.62       .000  .000      .00  *
*   765     82.00 -  82.50     27.00 - 27.50      2.478  .149   176.11       .000  .000      .00  *
*   766     82.00 -  82.50     27.50 - 28.00      2.478  .149   142.70       .000  .000      .00  *
*   767     82.00 -  82.50     28.00 - 28.50      2.779  .149   149.21       .000  .000      .00  *
*   768     82.00 -  82.50     28.50 - 29.00      3.527  .478   211.32       .000  .000      .00  *
*   769     82.00 -  82.50     29.00 - 29.50      3.555  .456   146.77      2.780  .175   278.94  *
*   770     82.00 -  82.50     29.50 - 30.00      3.620  .426    60.32      2.822  .122   239.38  *
*                                                                                       *
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*********************************************************************************************
*                            * SEISMIC MAP OF CONTINENTAL U.S. *                            *
*********************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)        A(N)   C(N)   R(N)  *
*********************************************************************************************
*                                                                                           *
*  771    82.00 -  82.50    30.00 - 30.50     3.652   .413   128.51      2.822   .122   209.92 *
*  772    82.00 -  82.50    30.50 - 31.00     3.673   .410   152.02      2.822   .122   181.08 *
*  773    82.00 -  82.50    31.00 - 31.50     3.708   .382   148.87      2.822   .122   153.14 *
*  774    82.00 -  82.50    31.50 - 32.00     3.740   .370   134.68      2.822   .122   126.55 *
*  775    82.00 -  82.50    32.00 - 32.50     3.771   .363   123.16      2.822   .122   102.00 *
*  776    82.00 -  82.50    32.50 - 33.00     3.787   .359   116.90      2.822   .122    81.06 *
*  777    82.00 -  82.50    33.00 - 33.50     3.905   .258   127.92      3.137   .085   103.07 *
*  778    82.00 -  82.50    33.50 - 34.00     3.934   .246   121.60      3.187   .085    92.16 *
*  779    82.00 -  82.50    34.00 - 34.50     3.939   .245   123.35      3.187   .085   114.13 *
*  780    82.00 -  82.50    34.50 - 35.00     3.950   .240   111.16      3.187   .085   132.76 *
*  781    82.00 -  82.50    35.00 - 35.50     3.964   .238   102.23      3.187   .085   134.25 *
*  782    82.00 -  82.50    35.50 - 36.00     3.968   .237    82.93      3.284   .137   133.73 *
*  783    82.00 -  82.50    36.00 - 36.50     3.994   .243   110.24      3.284   .137   104.58 *
*  784    82.00 -  82.50    36.50 - 37.00     4.060   .225    85.70      3.284   .137    66.67 *
*  785    82.00 -  82.50    37.00 - 37.50     4.028   .155   129.85      3.284   .137    28.13 *
*  786    82.00 -  82.50    37.50 - 38.00     4.025   .151   144.91      3.123   .122    53.06 *
*  787    82.00 -  82.50    38.00 - 38.50     4.031   .150   150.80      3.104   .146    79.98 *
*  788    82.00 -  82.50    38.50 - 39.00     4.069   .143   143.19      3.231   .173   108.00 *
*  789    82.00 -  82.50    39.00 - 39.50     4.069   .130    79.72      3.231   .173    82.71 *
*  790    82.00 -  82.50    39.50 - 40.00     4.053   .148    82.45      3.231   .173    27.71 *
*  791    82.00 -  82.50    40.00 - 40.50     4.031   .159   134.42      3.231   .173    88.73 *
*  792    82.00 -  82.50    40.50 - 41.00     4.005   .168   136.92      3.231   .173   146.62 *
*  793    82.00 -  82.50    41.00 - 41.50     3.987   .180   122.66      3.231   .173   188.62 *
*  794    82.00 -  82.50    41.50 - 42.00     3.904   .150    82.40      2.881   .298   171.66 *
*  795    82.00 -  82.50    42.00 - 42.50     3.857   .167   120.40      2.922   .255   195.51 *
*  796    82.00 -  82.50    42.50 - 43.00     3.892   .211   157.88      2.922   .255   209.35 *
*  797    82.00 -  82.50    43.00 - 43.50     3.880   .237   184.21      3.072   .282   247.86 *
*  798    82.00 -  82.50    43.50 - 44.00     3.822   .263   200.30      3.072   .282   262.88 *
*  799    82.00 -  82.50    44.00 - 44.50     3.807   .273   224.03      2.922   .255   266.49 *
*  800    82.00 -  82.50    44.50 - 45.00     3.733   .276   239.96      2.680   .206   226.95 *
*  801    82.00 -  82.50    45.00 - 45.50     3.562   .223   238.08      2.680   .206   238.10 *
*  802    82.00 -  82.50    45.50 - 46.00     3.547   .244   258.06      2.680   .206   250.32 *
*  803    82.00 -  82.50    46.00 - 46.50     3.518   .286   276.67      2.680   .206   263.98 *
*  804    82.00 -  82.50    46.50 - 47.00     3.350   .367   273.13      2.680   .206   279.73 *
*  805    82.50 -  83.00    25.00 - 25.50     2.688   .671   214.60       .000   .000      .00 *
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                          * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)   C(N)     R(N)

  806     82.50 -  83.00     25.50 - 26.00      2.906   .485   276.09       .000   .000      .00
  807     82.50 -  83.00     26.00 - 26.50      2.960   .414   287.17       .000   .000      .00
  808     82.50 -  83.00     26.50 - 27.00      2.960   .414   284.00       .000   .000      .00
  809     82.50 -  83.00     27.00 - 27.50      2.478   .149   179.44       .000   .000      .00
  810     82.50 -  83.00     27.50 - 28.00      2.478   .149   146.70       .000   .000      .00
  811     82.50 -  83.00     28.00 - 28.50      2.779   .149   155.54       .000   .000      .00
  812     82.50 -  83.00     28.50 - 29.00      3.527   .478   224.61       .000   .000      .00
  813     82.50 -  83.00     29.00 - 29.50      3.555   .456   173.45      2.780   .175   284.68
  814     82.50 -  83.00     29.50 - 30.00      3.620   .426   141.10      2.822   .122   245.02
  815     82.50 -  83.00     30.00 - 30.50      3.652   .413   160.79      2.822   .122   215.94
  816     82.50 -  83.00     30.50 - 31.00      3.673   .410   171.15      2.822   .122   167.36
  817     82.50 -  83.00     31.00 - 31.50      3.708   .382   164.93      2.822   .122   159.30
  818     82.50 -  83.00     31.50 - 32.00      3.740   .370   152.79      2.822   .122   131.58
  819     82.50 -  83.00     32.00 - 32.50      3.771   .363   141.10      2.822   .122   103.43
  820     82.50 -  83.00     32.50 - 33.00      3.787   .359   127.27      2.822   .122    73.75
  821     82.50 -  83.00     33.00 - 33.50      3.905   .258   124.43      3.187   .085    85.63
  822     82.50 -  83.00     33.50 - 34.00      3.930   .250    77.71      3.187   .085   103.99
  823     82.50 -  83.00     34.00 - 34.50      3.936   .248   122.90      3.187   .085   126.96
  824     82.50 -  83.00     34.50 - 35.00      3.958   .243   116.35      3.187   .085   140.99
  825     82.50 -  83.00     35.00 - 35.50      3.971   .241    65.47      3.187   .085   141.50
  826     82.50 -  83.00     35.50 - 36.00      3.975   .240    61.55      3.284   .137   142.92
  827     82.50 -  83.00     36.00 - 36.50      3.999   .247   108.24      3.284   .137   117.60
  828     82.50 -  83.00     36.50 - 37.00      4.090   .220   126.03      3.284   .137    87.46
  829     82.50 -  83.00     37.00 - 37.50      4.075   .159   143.93      3.284   .137    67.13
  830     82.50 -  83.00     37.50 - 38.00      4.073   .155   155.08      3.129   .122    70.00
  831     82.50 -  83.00     38.00 - 38.50      4.078   .155   153.81      3.104   .146    90.21
  832     82.50 -  83.00     38.50 - 39.00      4.116   .135   148.33      3.231   .173   116.30
  833     82.50 -  83.00     39.00 - 39.50      4.115   .125   102.39      3.231   .173    97.70
  834     82.50 -  83.00     39.50 - 40.00      4.102   .139   124.33      3.231   .173    71.98
  835     82.50 -  83.00     40.00 - 40.50      4.082   .148   132.64      3.231   .173   105.95
  836     82.50 -  83.00     40.50 - 41.00      4.060   .153   133.65      3.231   .173   155.08
  837     82.50 -  83.00     41.00 - 41.50      4.048   .150   134.76      3.231   .173   195.80
  838     82.50 -  83.00     41.50 - 42.00      3.971   .143   120.62      2.881   .298   180.64
  839     82.50 -  83.00     42.00 - 42.50      3.918   .151   117.27      2.922   .255   207.38
  840     82.50 -  83.00     42.50 - 43.00      3.938   .188   156.38      2.922   .295   223.71
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SEISMIC MAP OF CONTINENTAL U.S.

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
841	82.50 - 83.00	43.00 - 43.50	3.931	.272	189.41	2.922	.255	238.14
842	82.50 - 83.00	43.50 - 44.00	3.877	.301	203.27	2.922	.255	252.43
843	82.50 - 83.00	44.00 - 44.50	3.863	.311	228.94	2.680	.206	237.90
844	82.50 - 83.00	44.50 - 45.00	3.795	.319	248.74	2.680	.206	246.86
845	82.50 - 83.00	45.00 - 45.50	3.656	.291	255.61	2.680	.206	257.43
846	82.50 - 83.00	45.50 - 46.00	3.641	.310	273.24	2.680	.206	269.41
847	82.50 - 83.00	46.00 - 46.50	3.614	.348	288.28	2.680	.206	283.00
848	82.50 - 83.00	46.50 - 47.00	3.470	.427	282.02	2.680	.206	298.55
849	83.00 - 83.50	25.00 - 25.50	2.688	.671	234.87	.000	.000	.00
850	83.00 - 83.50	25.50 - 26.00	2.906	.485	292.26	.000	.000	.00
851	83.00 - 83.50	26.00 - 26.50	2.960	.414	299.79	.000	.000	.00
852	83.00 - 83.50	26.50 - 27.00	2.960	.414	295.20	.000	.000	.00
853	83.00 - 83.50	27.00 - 27.50	2.478	.149	187.31	.000	.000	.00
854	83.00 - 83.50	27.50 - 28.00	2.478	.149	156.21	.000	.000	.00
855	83.00 - 83.50	28.00 - 28.50	2.779	.149	169.71	.000	.000	.00
856	83.00 - 83.50	28.50 - 29.00	3.535	.468	248.54	.000	.000	.00
857	83.00 - 83.50	29.00 - 29.50	3.562	.449	213.22	2.780	.175	292.33
858	83.00 - 83.50	29.50 - 30.00	3.626	.420	196.53	2.822	.122	252.62
859	83.00 - 83.50	30.00 - 30.50	3.652	.413	193.98	2.822	.122	223.98
860	83.00 - 83.50	30.50 - 31.00	3.673	.410	191.70	2.822	.122	195.65
861	83.00 - 83.50	31.00 - 31.50	3.708	.382	181.34	2.822	.122	167.40
862	83.00 - 83.50	31.50 - 32.00	3.740	.370	168.36	2.822	.122	138.40
863	83.00 - 83.50	32.00 - 32.50	3.771	.363	154.46	2.822	.122	106.37
864	83.00 - 83.50	32.50 - 33.00	3.787	.359	133.11	2.822	.122	65.69
865	83.00 - 83.50	33.00 - 33.50	3.905	.258	96.90	3.187	.085	35.47
866	83.00 - 83.50	33.50 - 34.00	3.932	.252	114.81	3.187	.085	99.15
867	83.00 - 83.50	34.00 - 34.50	3.947	.248	128.38	3.187	.085	136.57
868	83.00 - 83.50	34.50 - 35.00	3.970	.243	124.27	3.187	.085	151.31
869	83.00 - 83.50	35.00 - 35.50	3.990	.243	105.63	3.187	.085	152.02
870	83.00 - 83.50	35.50 - 36.00	3.994	.242	97.24	3.206	.137	156.30
871	83.00 - 83.50	36.00 - 36.50	4.016	.250	104.32	3.284	.137	136.91
872	83.00 - 83.50	36.50 - 37.00	4.088	.221	123.23	3.377	.152	127.09
873	83.00 - 83.50	37.00 - 37.50	4.071	.163	144.72	3.377	.152	116.30
874	83.00 - 83.50	37.50 - 38.00	4.070	.159	156.46	3.278	.171	112.53
875	83.00 - 83.50	38.00 - 38.50	4.075	.159	154.36	3.266	.190	126.76

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*****************************************************************************************
*                         * SEISMIC MAP OF CONTINENTAL U.S. *                           *
*****************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)   C(H)    R(H)      A(N)   C(N)    R(N)    *
*****************************************************************************************
*
*   876    83.00 -  83.50    38.50 - 39.00      4.112  .140   146.99     3.341  .184   146.20  *
*   877    83.00 -  83.50    39.00 - 39.[illegible]      4.112  .130   135.89     3.341  .184   134.68  *
*   878    83.00 -  83.50    39.50 - 40.00      4.098  .145   127.79     3.341  .184   133.63  *
*   879    83.00 -  83.50    40.00 - 40.50      4.078  .154   115.06     3.341  .184   154.35  *
*   880    83.00 -  83.50    40.50 - 41.00      4.056  .161   111.16     3.341  .184   190.57  *
*   881    83.00 -  83.50    41.00 - 41.50      4.044  .164   123.47     3.341  .184   226.11  *
*   882    83.00 -  83.50    41.50 - 42.00      3.964  .153   119.96     3.139  .321   243.85  *
*   883    83.00 -  83.50    42.00 - 42.50      3.915  .155    70.00     2.889  .298   216.21  *
*   884    83.00 -  83.50    42.50 - 43.00      3.935  .193   147.67     2.889  .298   235.96  *
*   885    83.00 -  83.50    43.00 - 43.50      3.946  .258   183.49     2.922  .255   254.05  *
*   886    83.00 -  83.50    43.50 - 44.00      3.894  .265   179.39     3.314  .277   324.36  *
*   887    83.00 -  83.50    44.00 - 44.50      3.882  .294   212.44     3.152  .366   286.24  *
*   888    83.00 -  83.50    44.50 - 45.00      3.816  .300   247.81     3.152  .366   277.74  *
*   889    83.00 -  83.50    45.00 - 45.50      3.683  .269   258.06     3.152  .366   269.50  *
*   890    83.00 -  83.50    45.50 - 46.00      3.670  .286   276.09     3.152  .366   261.79  *
*   891    83.00 -  83.50    46.00 - 46.50      3.624  .334   287.54     3.152  .366   255.21  *
*   892    83.00 -  83.50    46.50 - 47.00      3.485  .409   281.49     3.152  .366   250.48  *
*   893    83.00 -  83.50    47.00 - 47.50      3.380  .371   264.06     3.080  .559   245.82  *
*   894    83.00 -  83.50    47.50 - 48.00      3.267  .468   247.39     3.080  .559   244.55  *
*   895    83.50 -  84.00    25.00 - 25.50      2.688  .671   257.48      .000  .000      .00  *
*   896    83.50 -  84.00    25.50 - 26.00      2.906  .485   310.88      .000  .000      .00  *
*   897    83.50 -  84.00    26.00 - 26.50      2.960  .414   315.29      .000  .000      .00  *
*   898    83.50 -  84.00    26.50 - 27.00      2.960  .414   309.92      .000  .000      .00  *
*   899    83.50 -  84.00    27.00 - 27.50      2.478  .149   199.19      .000  .000      .00  *
*   900    83.50 -  84.00    27.50 - 28.00      2.478  .149   170.33      .000  .000      .00  *
*   901    83.50 -  84.00    28.00 - 28.50      2.779  .149   139.26      .000  .000      .00  *
*   902    83.50 -  84.00    28.50 - 29.00      3.543  .460   274.29      .000  .000      .00  *
*   903    83.50 -  84.00    29.00 - 29.50      3.568  .442   245.86     2.780  .175   301.87  *
*   904    83.50 -  84.00    29.50 - 30.00      3.631  .415   230.16     2.822  .122   262.20  *
*   905    83.50 -  84.00    30.00 - 30.50      3.657  .408   220.70     2.822  .122   234.14  *
*   906    83.50 -  84.00    30.50 - 31.00      3.678  .405   211.93     2.822  .122   206.32  *
*   907    83.50 -  84.00    31.00 - 31.50      3.711  .379   197.04     2.822  .122   178.39  *
*   908    83.50 -  84.00    31.50 - 32.00      3.743  .368   182.38     2.822  .122   149.53  *
*   909    83.50 -  84.00    32.00 - 32.50      3.773  .362   166.62     2.822  .122   118.02  *
*   910    83.50 -  84.00    32.50 - 33.00      3.789  .358   145.47     2.822  .122    82.60  *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
S11	83.50 - 84.00	33.00 - 33.50	3.908	.254	135.53	3.187	.085	93.95
S12	83.50 - 84.00	33.50 - 34.00	3.920	.249	79.05	3.320	.132	142.20
S13	83.50 - 84.00	34.00 - 34.50	3.935	.245	129.89	3.320	.132	173.23
S14	83.50 - 84.00	34.50 - 35.00	3.959	.239	126.94	3.320	.132	185.38
S15	83.50 - 84.00	35.00 - 35.50	3.981	.238	108.64	3.320	.132	184.84
S16	83.50 - 84.00	35.50 - 36.00	3.985	.238	82.44	3.377	.152	182.67
S17	83.50 - 84.00	36.00 - 36.50	4.008	.245	69.17	3.377	.152	168.05
S18	83.50 - 84.00	36.50 - 37.00	4.076	.225	84.56	3.386	.139	154.33
S19	83.50 - 84.00	37.00 - 37.50	4.052	.167	139.39	3.386	.139	147.92
S20	83.50 - 84.00	37.50 - 38.00	4.055	.163	154.69	3.290	.154	138.54
S21	83.50 - 84.00	38.00 - 38.50	4.061	.163	150.33	3.278	.171	146.12
S22	83.50 - 84.00	38.50 - 39.00	4.051	.154	105.58	3.278	.171	152.67
S23	83.50 - 84.00	39.00 - 39.50	4.050	.144	128.73	3.278	.171	154.53
S24	83.50 - 84.00	39.50 - 40.00	4.036	.155	106.90	3.278	.171	158.53
S25	83.50 - 84.00	40.00 - 40.50	4.015	.161	75.65	3.278	.171	175.00
S26	83.50 - 84.00	40.50 - 41.00	3.990	.163	67.37	3.278	.171	203.07
S27	83.50 - 84.00	41.00 - 41.50	3.972	.172	94.48	3.278	.171	236.17
S28	83.50 - 84.00	41.50 - 42.00	3.860	.204	104.17	2.972	.411	244.28
S29	83.50 - 84.00	42.00 - 42.50	3.821	.187	103.33	2.521	.367	190.23
S30	83.50 - 84.00	42.50 - 43.00	3.864	.180	140.94	2.521	.367	221.99
S31	83.50 - 84.00	43.00 - 43.50	3.957	.266	180.26	2.922	.255	265.93
S32	83.50 - 84.00	43.50 - 44.00	3.911	.286	113.38	3.314	.277	327.08
S33	83.50 - 84.00	44.00 - 44.50	3.899	.295	212.62	3.152	.366	286.90
S34	83.50 - 84.00	44.50 - 45.00	3.838	.300	249.62	3.152	.366	277.05
S35	83.50 - 84.00	45.00 - 45.50	3.714	.267	262.93	3.152	.366	266.79
S36	83.50 - 84.00	45.50 - 46.00	3.702	.285	280.30	3.152	.366	257.14
S37	83.50 - 84.00	46.00 - 46.50	3.658	.332	290.76	3.148	.361	252.71
S38	83.50 - 84.00	46.50 - 47.00	3.534	.401	287.27	3.148	.361	244.88
S39	83.50 - 84.00	47.00 - 47.50	3.380	.371	256.09	3.074	.553	234.73
S40	83.50 - 84.00	47.50 - 48.00	3.267	.468	237.51	3.074	.553	232.18
S41	84.00 - 84.50	28.00 - 28.50	2.779	.148	211.94	.000	.000	.00
S42	84.00 - 84.50	28.50 - 29.00	3.543	[illegible]	298.03	.000	.000	.00
S43	84.00 - 84.50	29.00 - 29.50	3.568	.442	273.22	2.780	.175	313.28
S44	84.00 - 84.50	29.50 - 30.00	3.631	.415	255.54	2.822	.122	273.74
S45	84.00 - 84.50	30.00 - 30.50	3.657	.408	242.79	2.822	.122	246.49

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* SEISMIC MAP OF CONTINENTAL U.S. *

  GFID     LONG1 - LONG2     LAT1 - LAT2        A(H)    D(H)    R(H)        A(N)    D(N)    R(N)

  S46      84.00 - 84.50    30.50 - 31.00      3.678   .405   230.77       2.822   .122   219.58
  S47      84.00 - 84.50    31.00 - 31.50      3.711   .379   212.30       2.822   .122   192.78
  S48      84.00 - 84.50    31.50 - 32.00      3.743   .368   195.77       2.822   .122   165.77
  S49      84.00 - 84.50    32.00 - 32.50      3.773   .362   178.99       2.822   .122   138.47
  S50      84.00 - 84.50    32.50 - 33.00      3.793   .358   159.76       2.822   .122   113.46
  S51      84.00 - 84.50    33.00 - 33.50      3.912   .250   158.99       3.201   .066   150.68
  S52      84.00 - 84.50    33.50 - 34.00      3.923   .246   137.98       3.329   .118   179.84
  S53      84.00 - 84.50    34.00 - 34.50      3.939   .241   140.89       3.329   .118   193.13
  S54      84.00 - 84.50    34.50 - 35.00      3.962   .236   127.64       3.329   .118   198.09
  S55      84.00 - 84.50    35.00 - 35.50      3.983   .236    76.87       3.329   .118   196.75
  S56      84.00 - 84.50    35.50 - 36.00      3.987   .236    81.49       3.384   .139   196.21
  S57      84.00 - 84.50    36.00 - 36.50      4.011   .243    66.57       3.384   .139   185.26
  S58      84.00 - 84.50    36.50 - 37.00      4.134   .220   124.71       3.592   .251   209.33
  S59      84.00 - 84.50    37.00 - 37.50      4.150   .158   157.52       3.592   .251   204.30
  S60      84.00 - 84.50    37.50 - 38.00      4.153   .154   167.40       3.530   .274   195.43
  S61      84.00 - 84.50    38.00 - 38.50      4.158   .153   164.33       3.521   .285   199.99
  S62      84.00 - 84.50    38.50 - 39.00      4.158   .153   153.58       3.521   .285   206.58
  S63      84.00 - 84.50    39.00 - 39.50      4.154   .144   145.49       3.521   .285   213.46
  S64      84.00 - 84.50    39.50 - 40.00      4.140   .159   111.40       3.521   .285   223.31
  S65      84.00 - 84.50    40.00 - 40.50      4.123   .166    44.51       3.521   .285   240.12
  S66      84.00 - 84.50    40.50 - 41.00      4.099   .177    34.50       3.521   .285   264.02
  S67      84.00 - 84.50    41.00 - 41.50      4.052   .187    92.57       3.521   .285   292.16
  S68      84.00 - 84.50    41.50 - 42.00      3.849   .199   102.45       3.210   .404   287.70
  S69      84.00 - 84.50    42.00 - 42.50      3.833   .197   116.18       2.621   .255   204.67
  S70      84.00 - 84.50    42.50 - 43.00      3.876   .187   147.33       2.621   .255   229.57
  S71      84.00 - 84.50    43.00 - 43.50      3.909   .248   176.82       2.621   .255   255.12
  S72      84.00 - 84.50    43.50 - 44.00      3.864   .261   173.18       3.144   .361   299.55
  S73      84.00 - 84.50    44.00 - 44.50      3.852   .270   211.99       3.080   .559   302.47
  S74      84.00 - 84.50    44.50 - 45.00      3.787   .270   239.83       3.080   .559   282.07
  S75      84.00 - 84.50    45.00 - 45.50      3.641   .218   244.52       3.080   .559   262.52
  S76      84.00 - 84.50    45.50 - 46.00      3.628   .239   258.05       3.080   .559   244.59
  S77      84.00 - 84.50    46.00 - 46.50      3.580   .292   264.06       3.074   .553   233.23
  S78      84.00 - 84.50    46.50 - 47.00      3.440   .364   253.00       3.074   .553   220.10
  S79      84.00 - 84.50    47.00 - 47.50      3.380   .371   242.91       3.074   .553   211.84
  S80      84.00 - 84.50    47.50 - 48.00      3.267   .468   223.30       3.074   .553   209.01
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
981	84.00 - 84.50	48.00 - 48.50	3.241	.498	232.77	3.074	.553	211.84
982	84.00 - 84.50	48.50 - 49.00	3.241	.498	249.15	3.074	.553	220.10
983	84.00 - 84.50	49.00 - 49.50	3.241	.498	269.80	3.074	.553	233.23
984	84.00 - 84.50	49.50 - 50.00	3.206	.541	288.75	3.074	.553	250.46
985	84.50 - 85.00	28.00 - 28.50	2.828	.101	233.91	.000	.000	.00
986	84.50 - 85.00	28.50 - 29.00	3.549	.453	316.77	.000	.000	.00
987	84.50 - 85.00	29.00 - 29.50	3.573	.437	293.04	2.780	.175	326.50
988	84.50 - 85.00	29.50 - 30.00	3.635	.410	273.72	2.822	.122	287.18
989	84.50 - 85.00	30.00 - 30.50	3.661	.403	259.50	2.822	.122	260.98
990	84.50 - 85.00	30.50 - 31.00	3.682	.401	246.27	2.822	.122	235.35
991	84.50 - 85.00	31.00 - 31.50	3.717	.374	224.68	2.822	.122	210.32
992	84.50 - 85.00	31.50 - 32.00	3.747	.365	206.52	2.822	.122	186.08
993	84.50 - 85.00	32.00 - 32.50	3.781	.357	188.73	2.822	.122	163.56
994	84.50 - 85.00	32.50 - 33.00	3.834	.355	173.65	2.822	.122	145.72
995	84.50 - 85.00	33.00 - 33.50	4.019	.219	190.07	3.329	.118	213.83
996	84.50 - 85.00	33.50 - 34.00	4.027	.216	173.67	3.552	.256	256.83
997	84.50 - 85.00	34.00 - 34.50	4.040	.211	162.28	3.552	.256	255.59
998	84.50 - 85.00	34.50 - 35.00	4.057	.208	143.94	3.552	.256	251.75
999	84.50 - 85.00	35.00 - 35.50	4.073	.210	119.22	3.552	.256	244.13
1000	84.50 - 85.00	35.50 - 36.00	4.077	.209	97.08	3.592	.251	239.18
1001	84.50 - 85.00	36.00 - 36.50	4.095	.217	116.39	3.592	.251	228.19
1002	84.50 - 85.00	36.50 - 37.00	4.750	.683	269.54	3.794	.238	238.38
1003	84.50 - 85.00	37.00 - 37.50	4.758	.698	294.96	3.794	.238	235.41
1004	84.50 - 85.00	37.50 - 38.00	4.759	.697	297.91	3.760	.250	231.55
1005	84.50 - 85.00	38.00 - 38.50	4.761	.695	295.[illegible]1	3.759	.257	236.70
1006	84.50 - 85.00	38.50 - 39.00	4.757	.697	295.76	3.759	.257	245.07
1007	84.50 - 85.00	39.00 - 39.50	4.755	.698	290.83	3.759	.257	256.03
1008	84.50 - 85.00	39.50 - 40.00	4.750	.703	257.85	3.759	.257	270.15
1009	84.50 - 85.00	40.00 - 40.50	4.738	.713	198.38	3.687	.244	273.72
1010	84.50 - 85.00	40.50 - 41.00	4.717	.733	181.84	3.659	.245	290.91
1011	84.50 - 85.00	41.00 - 41.50	4.063	.185	107.09	3.564	.278	301.46
1012	84.50 - 85.00	41.50 - 42.00	3.855	.202	103.72	3.297	.376	302.02
1013	84.50 - 85.00	42.00 - 42.50	3.839	.200	105.50	2.881	.298	261.28
1014	84.50 - 85.00	42.50 - 43.00	3.792	.200	127.33	2.621	.255	233.72
1015	84.50 - 85.00	43.00 - 43.50	3.937	.243	187.92	2.621	.255	257.19

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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                              *
**************************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)   B(H)    R(H)         A(N)   B(N)    R(N)  *
**************************************************************************************************
*                                                                                                *
*  1C16    84.50 -  85.00    43.50 - 44.00      3.872  .271   201.01        3.148  .361   291.78 *
*  1C17    84.50 -  85.00    44.00 - 44.50      3.859  .280   225.75        3.080  .559   287.95 *
*  1C18    84.50 -  85.00    44.50 - 45.00      3.775  .278   240.27        3.080  .559   266.63 *
*  1C19    84.50 -  85.00    45.00 - 45.50      3.626  .228   239.55        3.080  .559   245.83 *
*  1C20    84.50 -  85.00    45.50 - 46.00      3.612  .249   248.47        3.080  .559   226.41 *
*  1C21    84.50 -  85.00    46.00 - 46.50      3.561  .306   249.16        3.074  .553   212.72 *
*  1C22    84.50 -  85.00    46.50 - 47.00      3.404  .393   227.61        3.074  .553   198.24 *
*  1C23    84.50 -  85.00    47.00 - 47.50      3.339  .404   214.91        3.074  .553   189.02 *
*  1C24    84.50 -  85.00    47.50 - 48.00      3.267  .468   205.45        3.074  .553   185.84 *
*  1C25    84.50 -  85.00    48.00 - 48.50      3.241  .498   215.30        3.074  .553   189.02 *
*  1C26    84.50 -  85.00    48.50 - 49.00      3.241  .498   233.32        3.074  .553   198.24 *
*  1C27    84.50 -  85.00    49.00 - 49.50      3.241  .498   255.80        3.074  .553   212.72 *
*  1C28    84.50 -  85.00    49.50 - 50.00      3.206  .541   276.53        3.074  .553   231.48 *
*  1C29    85.00 -  85.50    28.00 - 28.50      2.828  .101   252.19         .000  .000      .00 *
*  1C30    85.00 -  85.50    28.50 - 29.00      2.901  .028   233.22         .000  .000      .00 *
*  1C31    85.00 -  85.50    29.00 - 29.50      2.930  .001   217.14        2.444  .074   299.46 *
*  1C32    85.00 -  85.50    29.50 - 30.00      3.109  .129   210.86        2.534  .014   261.96 *
*  1C33    85.00 -  85.50    30.00 - 30.50      3.316  .158   239.80        2.534  .014   236.74 *
*  1C34    85.00 -  85.50    30.50 - 31.00      3.378  .196   235.07        2.534  .014   212.37 *
*  1C35    85.00 -  85.50    31.00 - 31.50      3.472  .105   217.35        2.534  .014   189.21 *
*  1C36    85.00 -  85.50    31.50 - 32.00      3.594  .089   210.30        3.016  .241   251.49 *
*  1C37    85.00 -  85.50    32.00 - 32.50      3.733  .040   203.47        3.152  .204   255.15 *
*  1C38    85.00 -  85.50    32.50 - 33.00      4.528  .829   356.17        3.351  .169   262.97 *
*  1C39    85.00 -  85.50    33.00 - 33.50      4.622  .755   349.53        3.585  .162   276.29 *
*  1C40    85.00 -  85.50    33.50 - 34.00      4.628  .750   316.95        3.722  .243   287.49 *
*  1C41    85.00 -  85.50    34.00 - 34.50      4.638  .742   293.53        3.749  .241   278.87 *
*  1C42    85.00 -  85.50    34.50 - 35.00      4.650  .733   267.21        3.749  .241   266.25 *
*  1C43    85.00 -  85.50    35.00 - 35.50      4.661  .725   185.04        3.749  .241   253.88 *
*  1C44    85.00 -  85.50    35.50 - 36.00      4.663  .723   235.08        3.773  .239   245.21 *
*  1C45    85.00 -  85.50    36.00 - 36.50      4.675  .716   208.14        3.773  .239   235.22 *
*  1C46    85.00 -  85.50    36.50 - 37.00      4.801  .646   275.84        3.832  .223   233.60 *
*  1C47    85.00 -  85.50    37.00 - 37.50      4.812  .660   290.46        3.832  .223   231.21 *
*  1C48    85.00 -  85.50    37.50 - 38.00      4.813  .659   281.51        3.800  .232   227.53 *
*  1C49    85.00 -  85.50    38.00 - 38.50      4.815  .658   262.14        3.796  .238   233.27 *
*  1C50    85.00 -  85.50    38.50 - 39.00      4.812  .660   283.86        3.796  .238   243.01 *
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                                *
*******************************************************************************************************
*  GRID     LONG1 - LONG2       LAT1 - LAT2        A(H)    B(H)    R(H)          A(N)    B(N)    R(N)  *
*******************************************************************************************************
*                                                                                                     *
*  1C51    85.00 -  85.50    39.00 - 39.50       4.809   .661   295.04        3.796   .238   256.11  *
*  1C52    85.00 -  85.50    39.50 - 40.00       4.787   .678   283.88        3.796   .238   272.24  *
*  1C53    85.00 -  85.50    40.00 - 40.50       4.769   .691   265.97        3.719   .236   276.18  *
*  1C54    85.00 -  85.50    40.50 - 41.00       4.751   .708   264.18        3.693   .236   293.61  *
*  1C55    85.00 -  85.50    41.00 - 41.50       4.133   .185   138.93        3.573   .267   301.09  *
*  1C56    85.00 -  85.50    41.50 - 42.00       3.944   .243   115.17        3.317   .349   300.42  *
*  1C57    85.00 -  85.50    42.00 - 42.50       3.932   .240    71.33        2.881   .298   262.94  *
*  1C58    85.00 -  85.50    42.50 - 43.00       3.868   .224   130.04        2.621   .255   236.33  *
*  1C59    85.00 -  85.50    43.00 - 43.50       3.893   .219   180.13        2.621   .255   258.09  *
*  1C60    85.00 -  85.50    43.50 - 44.00       3.827   .237   198.87        3.148   .361   284.20  *
*  1C61    85.00 -  85.50    44.00 - 44.50       3.814   .245   220.56        3.080   .559   274.41  *
*  1C62    85.00 -  85.50    44.50 - 45.00       3.727   .229   229.39        3.080   .559   252.21  *
*  1C63    85.00 -  85.50    45.00 - 45.50       3.542   .148   213.68        3.080   .559   230.07  *
*  1C64    85.00 -  85.50    45.50 - 46.00       3.527   .172   218.13        3.080   .559   209.01  *
*  1C65    85.00 -  85.50    46.00 - 46.50       3.449   .247   210.76        3.074   .553   192.82  *
*  1C66    85.00 -  85.50    46.50 - 47.00       3.266   .332   181.25        3.074   .553   176.71  *
*  1C67    85.00 -  85.50    47.00 - 47.50       3.181   .337   164.98        3.074   .553   166.30  *
*  1C68    85.00 -  85.50    47.50 - 48.00       3.109   .400   156.85        3.074   .553   162.68  *
*  1C69    85.00 -  85.50    48.00 - 48.50       3.079   .432   166.48        3.074   .553   166.30  *
*  1C70    85.00 -  85.50    48.50 - 49.00       3.241   .498   216.04        3.074   .553   176.71  *
*  1C71    85.00 -  85.50    49.00 - 49.50       3.241   .498   240.98        3.074   .553   192.82  *
*  1C72    85.00 -  85.50    49.50 - 50.00       3.206   .541   263.94        3.074   .553   213.33  *
*  1C73    85.50 -  86.00    28.00 - 28.50       2.828   .101   267.89         .000   .000      .00  *
*  1C74    85.50 -  86.00    28.50 - 29.00       2.901   .028   244.99         .000   .000      .00  *
*  1C75    85.50 -  86.00    29.00 - 29.50       2.930   .001   228.45        2.296   .225   311.59  *
*  1C76    85.50 -  86.00    29.50 - 30.00       3.109   .129   219.29        2.444   .074   282.20  *
*  1C77    85.50 -  86.00    30.00 - 30.50       3.316   .158   245.80        2.444   .074   255.61  *
*  1C78    85.50 -  86.00    30.50 - 31.00       3.370   .196   239.93        2.444   .074   230.35  *
*  1C79    85.50 -  86.00    31.00 - 31.50       3.576   .104   230.83        2.444   .074   206.96  *
*  1C80    85.50 -  86.00    31.50 - 32.00       3.709   .123   217.83        3.060   .216   278.43  *
*  1C81    85.50 -  86.00    32.00 - 32.50       3.787   .132   197.25        3.183   .187   277.04  *
*  1C82    85.50 -  86.00    32.50 - 33.00       4.599   .771   362.57        3.418   .184   279.48  *
*  1C83    85.50 -  86.00    33.00 - 33.50       4.644   .737   328.00        3.622   .175   287.17  *
*  1C84    85.50 -  86.00    33.50 - 34.00       4.649   .733   279.89        3.757   .237   290.26  *
*  1C85    85.50 -  86.00    34.00 - 34.50       4.667   .720   264.49        3.781   .236   275.63  *
*                                                                                                     *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1086	85.50 - 86.00	34.50 - 35.00	4.688	.706	264.79	3.781	.236	259.17
1087	85.50 - 86.00	35.00 - 35.50	4.700	.698	249.37	3.781	.236	244.22
1088	85.50 - 86.00	35.50 - 36.00	4.702	.697	247.00	3.809	.236	234.25
1089	85.50 - 86.00	36.00 - 36.50	4.715	.689	243.32	3.803	.236	223.49
1090	85.50 - 86.00	36.50 - 37.00	4.760	.658	254.21	3.832	.207	216.89
1091	85.50 - 86.00	37.00 - 37.50	4.816	.658	273.66	3.832	.207	213.83
1092	85.50 - 86.00	37.50 - 38.00	4.819	.635	256.88	3.822	.214	214.14
1093	85.50 - 86.00	38.00 - 38.50	4.821	.654	164.54	3.818	.221	220.73
1094	85.50 - 86.00	38.50 - 39.00	4.818	.655	259.86	3.818	.221	232.42
1095	85.50 - 86.00	39.00 - 39.50	4.816	.657	284.61	3.818	.221	247.90
1096	85.50 - 86.00	39.50 - 40.00	4.793	.674	290.53	3.818	.221	266.18
1097	85.50 - 86.00	40.00 - 40.50	4.776	.686	294.56	3.745	.216	273.25
1098	85.50 - 86.00	40.50 - 41.00	4.759	.702	303.76	3.707	.224	290.08
1099	85.50 - 86.00	41.00 - 41.50	4.153	.185	160.47	3.592	.251	300.76
1100	85.50 - 86.00	41.50 - 42.00	3.962	.252	124.14	3.317	.349	294.25
1101	85.50 - 86.00	42.00 - 42.50	3.951	.249	74.00	2.881	.298	261.12
1102	85.50 - 86.00	42.50 - 43.00	3.879	.222	134.29	2.621	.255	236.10
1103	85.50 - 86.00	43.00 - 43.50	3.889	.217	184.67	2.621	.255	256.90
1104	85.50 - 86.00	43.50 - 44.00	3.822	.235	203.96	3.148	.361	276.80
1105	85.50 - 86.00	44.00 - 44.50	3.809	.244	223.27	3.080	.559	262.01
1106	85.50 - 86.00	44.50 - 45.00	3.714	.237	225.91	3.080	.559	238.98
1107	85.50 - 86.00	45.00 - 45.50	3.526	.154	203.29	3.080	.559	215.47
1108	85.50 - 86.00	45.50 - 46.00	3.511	.180	202.67	3.080	.559	192.61
1109	85.50 - 86.00	46.00 - 46.50	3.425	.262	187.63	3.074	.553	173.73
1110	85.50 - 86.00	46.50 - 47.00	3.211	.378	146.77	3.074	.553	155.67
1111	85.50 - 86.00	47.00 - 47.50	3.109	.400	127.90	3.074	.553	143.74
1112	85.50 - 86.00	47.50 - 48.00	3.109	.400	134.33	3.074	.553	139.54
1113	85.50 - 86.00	48.00 - 48.50	3.079	.432	145.53	3.074	.553	143.74
1114	85.50 - 86.00	48.50 - 49.00	3.079	.432	166.67	3.074	.553	155.67
1115	85.50 - 86.00	49.00 - 49.50	3.079	.432	192.16	3.074	.553	173.73
1116	85.50 - 86.00	49.50 - 50.00	3.037	.483	214.85	3.074	.553	196.25
1117	86.00 - 86.50	29.00 - 29.50	2.717	.089	195.47	2.294	.225	325.95
1118	86.00 - 86.50	29.50 - 30.00	3.043	.098	221.57	2.444	.074	297.79
1119	86.00 - 86.50	30.00 - 30.50	3.261	.186	244.93	2.444	.074	272.76
1120	86.00 - 86.50	30.50 - 31.00	3.327	.225	238.17	2.444	.074	249.31

• SEISMIC MAP OF CONTINENTAL U.S. •

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	O(H)	R(H)	A(N)	O(N)	R(N)
1121	86.00 - 86.50	31.00 - 31.50	3.554	.116	230.72	2.444	.074	228.00
1122	86.00 - 86.50	31.50 - 32.00	3.696	.123	216.53	3.060	.216	284.54
1123	86.00 - 86.50	32.00 - 32.50	3.777	.128	194.30	3.222	.161	282.98
1124	86.00 - 86.50	32.50 - 33.00	4.595	.775	350.72	3.438	.173	277.14
1125	86.00 - 86.50	33.00 - 33.50	4.640	.741	307.27	3.636	.165	282.72
1126	86.00 - 86.50	33.50 - 34.00	4.645	.737	184.21	3.769	.228	282.01
1127	86.00 - 86.50	34.00 - 34.50	4.668	.720	181.61	3.792	.227	264.05
1128	86.00 - 86.50	34.50 - 35.00	4.689	.705	254.07	3.792	.227	245.03
1129	86.00 - 86.50	35.00 - 35.50	4.701	.697	250.91	3.792	.227	228.07
1130	86.00 - 86.50	35.50 - 36.00	4.703	.696	240.89	3.814	.227	217.15
1131	86.00 - 86.50	36.00 - 36.50	4.716	.689	234.71	3.814	.227	205.15
1132	86.00 - 86.50	36.50 - 37.00	4.743	.669	234.35	3.946	.249	212.79
1133	86.00 - 86.50	37.00 - 37.50	4.799	.669	248.92	3.946	.249	208.33
1134	86.00 - 86.50	37.50 - 38.00	4.803	.666	239.30	3.941	.251	208.70
1135	86.00 - 86.50	38.00 - 38.50	4.803	.666	223.48	3.938	.256	216.74
1136	86.00 - 86.50	38.50 - 39.00	4.800	.667	236.84	3.938	.256	231.07
1137	86.00 - 86.50	39.00 - 39.50	4.798	.669	261.36	3.938	.256	249.42
1138	86.00 - 86.50	39.50 - 40.00	4.772	.689	278.56	3.938	.256	270.26
1139	86.00 - 86.50	40.00 - 40.50	4.755	.701	296.43	3.885	.256	284.44
1140	86.00 - 86.50	40.50 - 41.00	4.737	.717	313.42	3.856	.266	304.44
1141	86.00 - 86.50	41.00 - 41.50	4.089	.191	161.24	3.774	.291	322.68
1142	86.00 - 86.50	41.50 - 42.00	3.959	.249	139.43	3.426	.382	303.77
1143	86.00 - 86.50	42.00 - 42.50	3.947	.245	130.16	2.881	.298	254.77
1144	86.00 - 86.50	42.50 - 43.00	3.874	.219	151.11	2.621	.255	231.76
1145	86.00 - 86.50	43.00 - 43.50	3.889	.217	193.44	2.621	.255	252.83
1146	86.00 - 86.50	43.50 - 44.00	3.822	.235	209.50	3.148	.361	269.67
1147	86.00 - 86.50	44.00 - 44.50	3.809	.244	225.02	3.080	.559	250.90
1148	86.00 - 86.50	44.50 - 45.00	3.714	.237	221.58	3.080	.559	227.16
1149	86.00 - 86.50	45.00 - 45.50	3.526	.154	191.43	3.080	.559	202.27
1150	86.00 - 86.50	45.50 - 46.00	3.511	.180	187.15	3.080	.559	177.50
1151	86.00 - 86.50	46.00 - 46.50	3.425	.262	167.48	3.074	.553	155.77
1152	86.00 - 86.50	46.50 - 47.00	3.211	.378	123.07	3.074	.553	135.33
1153	86.00 - 86.50	47.00 - 47.50	3.109	.400	104.37	3.074	.553	121.42
1154	86.00 - 86.50	47.50 - 48.00	3.109	.400	111.66	3.074	.553	116.41
1155	86.00 - 86.50	48.00 - 48.50	3.079	.432	125.50	3.074	.553	121.42

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                        * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID     LONG1 - LONG2     LAT1 - LAT2      A(H)    B(H)    R(H)       A(N)    B(N)    R(N)

  1156     86.00 - 86.50     48.50 - 49.00    3.079   .432   149.56      3.074   .553   135.33
  1157     86.00 - 86.50     49.00 - 49.50    3.079   .432   177.59      3.074   .553   155.77
  1158     86.00 - 86.50     49.50 - 50.00    3.037   .483   202.22      3.074   .553   180.54
  1159     86.50 - 87.00     29.00 - 29.50    2.901   .028   218.03      2.296   .225   342.15
  1160     86.50 - 87.00     29.50 - 30.00    3.095   .137   216.75      2.296   .225   314.98
  1161     86.50 - 87.00     30.00 - 30.50    3.303   .176   240.99      2.296   .225   289.37
  1162     86.50 - 87.00     30.50 - 31.00    3.303   .176   222.17      2.296   .225   265.79
  1163     86.50 - 87.00     31.00 - 31.50    3.537   .093   219.14      2.296   .225   244.81
  1164     86.50 - 87.00     31.50 - 32.00    3.684   .109   206.96      3.040   .237   295.78
  1165     86.50 - 87.00     32.00 - 32.50    3.766   .120   184.95      3.207   .184   287.02
  1166     86.50 - 87.00     32.50 - 33.00    4.592   .777   337.15      3.429   .186   273.70
  1167     86.50 - 87.00     33.00 - 33.50    4.638   .742   306.61      3.731   .205   293.72
  1168     86.50 - 87.00     33.50 - 34.00    4.643   .738   262.96      3.878   .272   288.87
  1169     86.50 - 87.00     34.00 - 34.50    4.666   .722   248.47      3.896   .270   266.05
  1170     86.50 - 87.00     34.50 - 35.00    4.686   .708   248.26      3.896   .270   243.51
  1171     86.50 - 87.00     35.00 - 35.50    4.698   .699   237.68      3.896   .270   223.53
  1172     86.50 - 87.00     35.50 - 36.00    4.700   .698   223.65      3.914   .268   209.76
  1173     86.50 - 87.00     36.00 - 36.50    4.714   .690   214.47      3.914   .268   195.65
  1174     86.50 - 87.00     36.50 - 37.00    4.741   .671   212.03      3.938   .256   187.52
  1175     86.50 - 87.00     37.00 - 37.50    4.797   .671   223.90      3.938   .256   180.77
  1176     86.50 - 87.00     37.50 - 38.00    4.801   .668   218.22      3.932   .258   179.80
  1177     86.50 - 87.00     38.00 - 38.50    4.801   .668   211.40      3.929   .263   189.91
  1178     86.50 - 87.00     38.50 - 39.00    4.798   .669   186.91      3.929   .263   208.22
  1179     86.50 - 87.00     39.00 - 39.50    4.795   .671   231.75      3.929   .263   230.33
  1180     86.50 - 87.00     39.50 - 40.00    4.770   .691   264.39      3.929   .263   254.15
  1181     86.50 - 87.00     40.00 - 40.50    4.752   .704   293.92      3.879   .264   270.54
  1182     86.50 - 87.00     40.50 - 41.00    4.733   .720   317.98      3.845   .275   291.63
  1183     86.50 - 87.00     41.00 - 41.50    4.082   .193   169.59      3.760   .303   309.95
  1184     86.50 - 87.00     41.50 - 42.00    3.957   .250   153.61      3.426   .382   291.08
  1185     86.50 - 87.00     42.00 - 42.50    3.945   .247   158.91      2.881   .298   242.88
  1186     86.50 - 87.00     42.50 - 43.00    3.871   .221   168.47      2.621   .255   222.32
  1187     86.50 - 87.00     43.00 - 43.50    3.878   .222   201.80      2.621   .255   245.43
  1188     86.50 - 87.00     43.50 - 44.00    3.809   .244   213.32      3.148   .361   262.95
  1189     86.50 - 87.00     44.00 - 44.50    3.795   .253   223.89      3.080   .559   241.25
  1190     86.50 - 87.00     44.50 - 45.00    3.697   .249   210.86      3.080   .559   216.96
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                            *
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*   GFID     LONG1 - LONG2      LAT1 - LAT2        A(H)   O(H)    R(H)        A(N)   O(N)    R(N)  *
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*                                                                                                  *
*   1191    86.50 -  87.00    45.00 - 45.50      3.503   .166   169.58       3.080   .559   190.76 *
*   1192    86.50 -  87.00    45.50 - 46.00      3.486   .192   165.54       3.080   .559   164.05 *
*   1193    86.50 -  87.00    46.00 - 46.50      3.388   .288   141.04       3.074   .553   139.36 *
*   1194    86.50 -  87.00    46.50 - 47.00      3.211   .378    99.27       3.074   .553   116.06 *
*   1195    86.50 -  87.00    47.00 - 47.50      3.109   .400    80.18       3.074   .553    99.50 *
*   1196    86.50 -  87.00    47.50 - 48.00      3.109   .400    89.14       3.074   .553    93.32 *
*   1197    86.50 -  87.00    48.00 - 48.50      3.079   .432   107.03       3.074   .553    99.50 *
*   1198    86.50 -  87.00    48.50 - 49.00      3.079   .432   134.55       3.074   .553   116.06 *
*   1199    86.50 -  87.00    49.00 - 49.50      3.079   .432   165.23       3.074   .553   139.36 *
*   1200    86.50 -  87.00    49.50 - 50.00      3.037   .483   191.74       3.074   .553   166.59 *
*   1201    87.00 -  87.50    29.00 - 29.50      2.717   .089   172.48       2.296   .225   359.93 *
*   1202    87.00 -  87.50    29.50 - 30.00      3.043   .098   204.59       2.296   .225   334.21 *
*   1203    87.00 -  87.50    30.00 - 30.50      3.261   .186   227.90       2.296   .225   310.20 *
*   1204    87.00 -  87.50    30.50 - 31.00      3.261   .186   209.74       2.296   .225   288.33 *
*   1205    87.00 -  87.50    31.00 - 31.50      3.520   .096   212.38       2.296   .225   269.11 *
*   1206    87.00 -  87.50    31.50 - 32.00      3.670   .108   199.38       3.040   .237   294.08 *
*   1207    87.00 -  87.50    32.00 - 32.50      3.758   .113   172.62       3.207   .184   281.23 *
*   1208    87.00 -  87.50    32.50 - 33.00      4.586   .781   313.13       3.429   .186   264.25 *
*   1209    87.00 -  87.50    33.00 - 33.50      4.633   .746   301.57       3.719   .222   279.41 *
*   1210    87.00 -  87.50    33.50 - 34.00      4.638   .742   275.66       3.863   .287   272.14 *
*   1211    87.00 -  87.50    34.00 - 34.50      4.664   .723   255.90       3.882   .284   247.13 *
*   1212    87.00 -  87.50    34.50 - 35.00      4.684   .709   237.93       3.882   .284   222.14 *
*   1213    87.00 -  87.50    35.00 - 35.50      4.693   .702   218.73       3.882   .284   200.05 *
*   1214    87.00 -  87.50    35.50 - 36.00      4.693   .702   200.12       3.882   .284   181.42 *
*   1215    87.00 -  87.50    36.00 - 36.50      4.707   .694   188.08       3.882   .284   166.09 *
*   1216    87.00 -  87.50    36.50 - 37.00      4.741   .670   185.09       3.914   .268   157.92 *
*   1217    87.00 -  87.50    37.00 - 37.50      4.796   .671   193.53       3.914   .268   147.16 *
*   1218    87.00 -  87.50    37.50 - 38.00      4.799   .669   183.54       3.908   .270   142.93 *
*   1219    87.00 -  87.50    38.00 - 38.50      4.798   .669   178.31       3.908   .270   157.51 *
*   1220    87.00 -  87.50    38.50 - 39.00      4.796   .671   140.20       3.908   .270   182.00 *
*   1221    87.00 -  87.50    39.00 - 39.50      4.794   .672   182.47       3.908   .270   208.59 *
*   1222    87.00 -  87.50    39.50 - 40.00      4.769   .692   246.70       3.908   .270   235.56 *
*   1223    87.00 -  87.50    40.00 - 40.50      4.751   .705   287.62       3.852   .272   253.94 *
*   1224    87.00 -  87.50    40.50 - 41.00      4.732   .722   317.52       3.820   .284   275.57 *
*   1225    87.00 -  87.50    41.00 - 41.50      4.079   .198   174.44       3.727   .317   291.38 *
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*                           * SEISMIC MAP OF CONTINENTAL U.S. *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)      A(N)    C(N)    R(N)
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   1226    87.00 - 87.50     41.50 - 42.00     3.950   .255   160.54     3.426   .382   275.11
   1227    87.00 - 87.50     42.00 - 42.50     3.938   .253   169.82     2.881   .298   224.34
   1228    87.00 - 87.50     42.50 - 43.00     3.863   .230   178.34     2.621   .255   207.41
   1229    87.00 - 87.50     43.00 - 43.50     3.874   .228   208.09     2.621   .255   234.84
   1230    87.00 - 87.50     43.50 - 44.00     3.804   .251   216.73     3.144   .361   256.86
   1231    87.00 - 87.50     44.00 - 44.50     3.790   .261   223.10     3.080   .559   233.26
   1232    87.00 - 87.50     44.50 - 45.00     3.690   .259   195.78     3.080   .559   208.63
   1233    87.00 - 87.50     45.00 - 45.50     3.495   .178   131.31     3.080   .559   181.28
   1234    87.00 - 87.50     45.50 - 46.00     3.486   .192   146.50     3.080   .559   152.73
   1235    87.00 - 87.50     46.00 - 46.50     3.388   .288   123.13     3.074   .553   125.12
   1236    87.00 - 87.50     46.50 - 47.00     3.211   .378    76.21     3.074   .553    98.51
   1237    87.00 - 87.50     47.00 - 47.50     3.109   .400    55.30     3.074   .553    78.31
   1238    87.00 - 87.50     47.50 - 48.00     3.109   .400    67.63     3.074   .553    70.30
   1239    87.00 - 87.50     48.00 - 48.50     3.079   .432    91.22     3.074   .553    78.31
   1240    87.00 - 87.50     48.50 - 49.00     3.079   .432   122.48     3.074   .553    98.51
   1241    87.00 - 87.50     49.00 - 49.50     3.079   .432   155.65     3.074   .553   125.12
   1242    87.00 - 87.50     49.50 - 50.00     3.037   .483   183.81     3.074   .553   154.88
   1243    87.50 - 88.00     29.00 - 29.50     2.717   .089   153.75     2.722   .255   318.54
   1244    87.50 - 88.00     29.50 - 30.00     2.996   .032   176.56     2.722   .255   322.36
   1245    87.50 - 88.00     30.00 - 30.50     3.226   .184   202.30     2.722   .255   326.46
   1246    87.50 - 88.00     30.50 - 31.00     3.275   .167   197.65     2.722   .255   330.22
   1247    87.50 - 88.00     31.00 - 31.50     3.501   .104   201.52     2.722   .255   333.39
   1248    87.50 - 88.00     31.50 - 32.00     3.629   .090   185.32     3.166   .211   313.25
   1249    87.50 - 88.00     32.00 - 32.50     3.725   .094   153.10     3.207   .184   274.54
   1250    87.50 - 88.00     32.50 - 33.00     4.575   .789   229.62     3.429   .186   254.74
   1251    87.50 - 88.00     33.00 - 33.50     4.625   .752   287.02     3.715   .222   266.52
   1252    87.50 - 88.00     33.50 - 34.00     4.630   .747   267.89     3.863   .287   257.31
   1253    87.50 - 88.00     34.00 - 34.50     4.657   .728   244.93     3.882   .284   229.87
   1254    87.50 - 88.00     34.50 - 35.00     4.678   .712   220.87     3.882   .284   202.24
   1255    87.50 - 88.00     35.00 - 35.50     4.687   .706   196.53     3.882   .284   177.88
   1256    87.50 - 88.00     35.50 - 36.00     4.687   .706   173.76     3.882   .284   157.82
   1257    87.50 - 88.00     36.00 - 36.50     4.702   .697   158.69     3.882   .284   141.63
   1258    87.50 - 88.00     36.50 - 37.00     4.735   .674   154.17     3.892   .276   128.58
   1259    87.50 - 88.00     37.00 - 37.50     4.790   .675   161.31     3.892   .276   112.41
   1260    87.50 - 88.00     37.50 - 38.00     4.792   .673   125.19     3.884   .278    96.86

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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                            *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)   B(H)    R(H)       A(N)   B(N)    R(N)   *
*******************************************************************************************
*                                                                                         *
*  1261    87.50 -  88.00    38.00 - 38.50      4.792  .674   126.01     3.886  .278   123.56   *
*  1262    87.50 -  88.00    38.50 - 39.00      4.789  .675   122.04     3.886  .278   157.13   *
*  1263    87.50 -  88.00    39.00 - 39.50      4.787  .677   147.63     3.874  .287   186.46   *
*  1264    87.50 -  88.00    39.50 - 40.00      4.761  .697   234.82     3.874  .287   216.66   *
*  1265    87.50 -  88.00    40.00 - 40.50      4.743  .710   280.33     3.815  .292   236.48   *
*  1266    87.50 -  88.00    40.50 - 41.00      4.723  .728   312.30     3.779  .306   257.99   *
*  1267    87.50 -  88.00    41.00 - 41.50      4.062  .194   171.65     3.671  .349   267.00   *
*  1268    87.50 -  88.00    41.50 - 42.00      3.931  .247   156.04     3.361  .404   243.70   *
*  1269    87.50 -  88.00    42.00 - 42.50      3.918  .244   167.02     2.621  .255   154.30   *
*  1270    87.50 -  88.00    42.50 - 43.00      3.837  .221   175.43     2.071  .000   104.04   *
*  1271    87.50 -  88.00    43.00 - 43.50      3.862  .248   208.69     2.621  .255   222.15   *
*  1272    87.50 -  88.00    43.50 - 44.00      3.788  .277   217.41     3.148  .361   251.71   *
*  1273    87.50 -  88.00    44.00 - 44.50      3.772  .288   221.85     3.080  .559   227.11   *
*  1274    87.50 -  88.00    44.50 - 45.00      3.668  .294   182.78     3.080  .559   202.39   *
*  1275    87.50 -  88.00    45.00 - 45.50      3.467  .224    66.87     3.080  .559   174.16   *
*  1276    87.50 -  88.00    45.50 - 46.00      3.467  .224   131.81     3.080  .559   144.07   *
*  1277    87.50 -  88.00    46.00 - 46.50      3.388  .288   110.34     3.074  .553   113.86   *
*  1278    87.50 -  88.00    46.50 - 47.00      3.211  .378    56.51     3.074  .553    83.75   *
*  1279    87.50 -  88.00    47.00 - 47.50      3.109  .400    30.14     3.074  .553    58.67   *
*  1280    87.50 -  88.00    47.50 - 48.00      3.109  .400    49.61     3.074  .553    47.46   *
*  1281    87.50 -  88.00    48.00 - 48.50      3.079  .432    79.90     3.074  .553    58.67   *
*  1282    87.50 -  88.00    48.50 - 49.00      3.079  .432   114.39     3.074  .553    83.75   *
*  1283    87.50 -  88.00    49.00 - 49.50      3.079  .432   149.43     3.074  .553   113.86   *
*  1284    87.50 -  88.00    49.50 - 50.00      3.037  .483   178.74     3.074  .553   145.93   *
*  1285    88.00 -  88.50    28.00 - 28.50      2.566  .061   170.79     2.521  .367   246.88   *
*  1286    88.00 -  88.50    28.50 - 29.00      2.677  .049   152.98     2.521  .367   254.01   *
*  1287    88.00 -  88.50    29.00 - 29.50      2.677  .049   129.94     2.521  .367   265.47   *
*  1288    88.00 -  88.50    29.50 - 30.00      2.978  .054   150.35     2.521  .367   280.72   *
*  1289    88.00 -  88.50    30.00 - 30.50      3.211  .203   172.76     2.521  .367   299.19   *
*  1290    88.00 -  88.50    30.50 - 31.00      3.261  .186   178.04     2.722  .255   337.55   *
*  1291    88.00 -  88.50    31.00 - 31.50      3.495  .112   194.35     2.722  .255   345.51   *
*  1292    88.00 -  88.50    31.50 - 32.00      3.625  .096   182.15     3.164  .211   310.35   *
*  1293    88.00 -  88.50    32.00 - 32.50      3.723  .094   151.76     3.207  .184   269.13   *
*  1294    88.00 -  88.50    32.50 - 33.00      4.575  .790   226.90     3.429  .186   246.15   *
*  1295    88.00 -  88.50    33.00 - 33.50      4.624  .752   279.63     3.715  .222   254.61   *
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                             * SEISMIC MAP OF CONTINENTAL U.S. *

   GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)   D(H)    R(H)        A(N)   D(N)    R(N)

   1296    88.00 -  88.50    33.50 - 34.00      4.630  .748   257.85       3.863  .287   243.48
   1297    88.00 -  88.50    34.00 - 34.50      4.656  .728   230.72       3.882  .284   213.41
   1298    88.00 -  88.50    34.50 - 35.00      4.677  .713   202.52       3.882  .284   182.67
   1299    88.00 -  88.50    35.00 - 35.50      4.686  .707   174.06       3.882  .284   155.39
   1300    88.00 -  88.50    35.50 - 36.00      4.686  .707   147.26       3.882  .284   133.96
   1301    88.00 -  88.50    36.00 - 36.50      4.701  .698   127.75       3.882  .264   117.93
   1302    88.00 -  88.50    36.50 - 37.00      4.728  .679   119.54       3.892  .276   104.43
   1303    88.00 -  88.50    37.00 - 37.50      4.783  .680   125.53       3.892  .276    86.06
   1304    88.00 -  88.50    37.50 - 38.00      4.785  .678   143.35       3.886  .278    45.15
   1305    88.00 -  88.50    38.00 - 38.50      4.786  .678   157.68       3.886  .278   100.93
   1306    88.00 -  88.50    38.50 - 39.00      4.783  .680   171.09       3.886  .278   139.40
   1307    88.00 -  88.50    39.00 - 39.50      4.781  .681   197.08       3.876  .287   171.19
   1308    88.00 -  88.50    39.50 - 40.00      4.757  .700   236.35       3.876  .287   203.23
   1309    88.00 -  88.50    40.00 - 40.50      4.742  .711   275.96       3.815  .292   224.11
   1310    88.00 -  88.50    40.50 - 41.00      4.722  .729   307.06       3.779  .306   244.53
   1311    88.00 -  88.50    41.00 - 41.50      4.060  .197   164.79       3.671  .349   246.39
   1312    88.00 -  88.50    41.50 - 42.00      3.928  .249   134.42       3.361  .404   207.02
   1313    88.00 -  88.50    42.00 - 42.50      3.915  .247   155.24       2.621  .255   121.64
   1314    88.00 -  88.50    42.50 - 43.00      3.834  .225   164.31       2.071  .000    86.67
   1315    88.00 -  88.50    43.00 - 43.50      3.830  .257   196.40       2.071  .000   116.03
   1316    88.00 -  88.50    43.50 - 44.00      3.766  .298   213.30       3.080  .559   240.48
   1317    88.00 -  88.50    44.00 - 44.50      3.766  .298   224.44       3.080  .559   223.02
   1318    88.00 -  88.50    44.50 - 45.00      3.659  .308   193.13       3.080  .559   198.45
   1319    88.00 -  88.50    45.00 - 45.50      3.456  .242   124.69       3.080  .559   169.71
   1320    88.00 -  88.50    45.50 - 46.00      3.456  .242   135.67       3.080  .559   138.59
   1321    88.00 -  88.50    46.00 - 46.50      3.388  .288   105.80       3.074  .553   106.54
   1322    88.00 -  88.50    46.50 - 47.00      3.211  .378    47.19       3.074  .553    73.48
   1323    88.00 -  88.50    47.00 - 47.50      3.109  .400    12.04       3.074  .553    42.76
   1324    88.00 -  88.50    47.50 - 48.00      3.109  .400    41.21       3.074  .553    25.26
   1325    88.00 -  88.50    48.00 - 48.50      3.079  .432    75.25       3.074  .553    42.76
   1326    88.00 -  88.50    48.50 - 49.00      3.079  .432   111.19       3.074  .553    73.48
   1327    88.00 -  88.50    49.00 - 49.50      3.079  .432   147.03       3.074  .553   106.54
   1328    88.00 -  88.50    49.50 - 50.00      3.037  .483   176.78       3.074  .553   140.29
   1329    88.50 -  89.00    28.00 - 28.50      2.566  .061   156.26       2.521  .367   216.72
   1330    88.50 -  89.00    28.50 - 29.00      2.677  .049   138.91       2.521  .367   224.81
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                              * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    B(H)    R(H)        A(N)    B(N)    R(N)

  1331    88.50 - 89.00     29.00 - 29.50     2.677    .049   112.34      2.529    .367   237.68
  1332    88.50 - 89.00     29.50 - 30.00     2.886    .072   106.21      2.529    .367   254.60
  1333    88.50 - 89.00     30.00 - 30.50     3.165    .215   114.01      2.529    .367   274.83
  1334    88.50 - 89.00     30.50 - 31.00     3.226    .184   144.85      2.722    .255   315.92
  1335    88.50 - 89.00     31.00 - 31.50     3.479    .116   184.43      2.722    .255   324.93
  1336    88.50 - 89.00     31.50 - 32.00     3.612    .092   181.24      3.164    .211   299.37
  1337    88.50 - 89.00     32.00 - 32.50     3.689    .075   157.01      3.207    .184   259.55
  1338    88.50 - 89.00     32.50 - 33.00     4.561    .801   290.03      3.429    .186   236.95
  1339    88.50 - 89.00     33.00 - 33.50     4.613    .761   276.12      3.719    .222   243.77
  1340    88.50 - 89.00     33.50 - 34.00     4.619    .756   244.38      3.863    .287   231.52
  1341    88.50 - 89.00     34.00 - 34.50     4.647    .735   213.57      3.882    .284   199.09
  1342    88.50 - 89.00     34.50 - 35.00     4.669    .719   182.72      3.882    .284   164.63
  1343    88.50 - 89.00     35.00 - 35.50     4.678    .712   150.35      3.882    .284   132.56
  1344    88.50 - 89.00     35.50 - 36.00     4.678    .712   120.80      3.882    .284   108.88
  1345    88.50 - 89.00     36.00 - 36.50     4.694    .702    95.97      3.882    .284    94.69
  1346    88.50 - 89.00     36.50 - 37.00     4.727    .679    80.09      3.882    .284    81.07
  1347    88.50 - 89.00     37.00 - 37.50     4.782    .680    98.40      3.882    .284    58.98
  1348    88.50 - 89.00     37.50 - 38.00     4.785    .678   128.13      3.884    .278    66.07
  1349    88.50 - 89.00     38.00 - 38.50     4.783    .679   155.51      3.884    .278    92.02
  1350    88.50 - 89.00     38.50 - 39.00     4.780    .682   177.09      3.884    .278   126.43
  1351    88.50 - 89.00     39.00 - 39.50     4.778    .683   206.13      3.874    .287   159.52
  1352    88.50 - 89.00     39.50 - 40.00     4.754    .702   236.55      3.874    .287   193.02
  1353    88.50 - 89.00     40.00 - 40.50     4.739    .713   271.43      3.815    .292   214.75
  1354    88.50 - 89.00     40.50 - 41.00     4.718    .731   301.46      3.779    .306   233.67
  1355    88.50 - 89.00     41.00 - 41.50     4.051    .190   156.90      3.671    .349   220.42
  1356    88.50 - 89.00     41.50 - 42.00     3.916    .240    77.04      3.361    .404   143.38
  1357    88.50 - 89.00     42.00 - 42.50     3.904    .237   139.62      2.629    .255    90.50
  1358    88.50 - 89.00     42.50 - 43.00     3.819    .213   129.85      2.071    .000    74.32
  1359    88.50 - 89.00     43.00 - 43.50     3.824    .265   178.97      2.071    .000   107.12
  1360    88.50 - 89.00     43.50 - 44.00     3.766    .298   212.03      3.080    .559   237.35
  1361    88.50 - 89.00     44.00 - 44.50     3.766    .298   230.08      3.080    .559   221.17
  1362    88.50 - 89.00     44.50 - 45.00     3.659    .308   210.86      3.080    .559   196.94
  1363    88.50 - 89.00     45.00 - 45.50     3.456    .242   158.88      3.080    .559   168.13
  1364    88.50 - 89.00     45.50 - 46.00     3.456    .242   147.55      3.080    .559   136.68
  1365    88.50 - 89.00     46.00 - 46.50     3.388    .288   110.96      3.074    .553   103.98
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	P(N)	R(N)
1366	88.50 - 89.00	46.50 - 47.00	3.211	.378	53.88	3.074	.553	69.72
1367	88.50 - 89.00	47.00 - 47.50	3.109	.400	23.42	3.074	.553	35.92
1368	88.50 - 89.00	47.50 - 48.00	3.109	.400	47.14	3.074	.553	10.00
1369	88.50 - 89.00	48.00 - 48.50	3.079	.432	78.37	3.074	.553	35.92
1370	88.50 - 89.00	48.50 - 49.00	3.176	.353	127.69	3.074	.553	69.72
1371	88.50 - 89.00	49.00 - 49.50	3.176	.353	165.97	3.074	.553	103.98
1372	88.50 - 89.00	49.50 - 50.00	3.147	.394	200.51	3.074	.553	138.36
1373	89.00 - 89.50	28.00 - 28.50	2.622	.061	157.24	2.722	.255	219.08
1374	89.00 - 89.50	28.50 - 29.00	2.733	.049	139.21	2.722	.255	224.89
1375	89.00 - 89.50	29.00 - 29.50	2.733	.049	109.41	2.722	.255	234.43
1376	89.00 - 89.50	29.50 - 30.00	2.942	.072	93.94	2.722	.255	246.14
1377	89.00 - 89.50	30.00 - 30.50	3.221	.215	49.67	2.722	.255	258.96
1378	89.00 - 89.50	30.50 - 31.00	3.282	.184	134.83	2.839	.206	278.51
1379	89.00 - 89.50	31.00 - 31.50	3.523	.134	193.85	2.839	.206	284.33
1380	89.00 - 89.50	31.50 - 32.00	3.656	.111	198.04	3.207	.184	281.68
1381	89.00 - 89.50	32.00 - 32.50	3.724	.069	177.82	3.241	.164	248.56
1382	89.00 - 89.50	32.50 - 33.00	4.609	.808	325.20	3.449	.176	229.52
1383	89.00 - 89.50	33.00 - 33.50	4.663	.767	296.71	3.728	.213	236.40
1384	89.00 - 89.50	33.50 - 34.00	4.669	.762	251.64	3.877	.279	223.82
1385	89.00 - 89.50	34.00 - 34.50	4.698	.739	209.90	3.892	.276	189.84
1386	89.00 - 89.50	34.50 - 35.00	4.720	.723	178.77	3.892	.276	151.42
1387	89.00 - 89.50	35.00 - 35.50	4.730	.716	132.94	3.892	.276	110.64
1388	89.00 - 89.50	35.50 - 36.00	4.730	.716	106.71	3.882	.284	77.84
1389	89.00 - 89.50	36.00 - 36.50	4.734	.713	69.89	3.882	.284	70.38
1390	89.00 - 89.50	36.50 - 37.00	4.779	.683	49.52	3.882	.284	59.56
1391	89.00 - 89.50	37.00 - 37.50	4.778	.684	56.80	3.882	.284	38.97
1392	89.00 - 89.50	37.50 - 38.00	4.781	.682	110.90	3.886	.278	40.81
1393	89.00 - 89.50	38.00 - 38.50	4.781	.682	142.66	3.886	.278	79.63
1394	89.00 - 89.50	38.50 - 39.00	4.777	.684	154.74	3.886	.278	115.47
1395	89.00 - 89.50	39.00 - 39.50	4.775	.685	198.06	3.876	.287	151.46
1396	89.00 - 89.50	39.50 - 40.00	4.747	.707	229.35	3.876	.287	186.26
1397	89.00 - 89.50	40.00 - 40.50	4.732	.718	263.16	3.815	.292	208.76
1398	89.00 - 89.50	40.50 - 41.00	4.714	.735	296.14	3.779	.306	227.36
1399	89.00 - 89.50	41.00 - 41.50	4.046	.196	160.94	3.671	.349	202.75
1400	89.00 - 89.50	41.50 - 42.00	3.911	.245	130.52	3.361	.404	62.79

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********************************************************************************************
*                              * SEISMIC MAP OF CONTINENTAL U.S. *                         *
********************************************************************************************
*  GFID    LONG1 - LONG2     LAT1 - LAT2      A(H)   C(H)   R(H)       A(N)   B(N)    R(N)  *
********************************************************************************************
*                                                                                          *
*  1401   89.00 - 89.50    42.00 - 42.50     3.698  .242  138.32      2.621  .255   75.26  *
*  1402   89.00 - 89.50    42.50 - 43.00     3.812  .221   66.35      2.071  .000   69.72  *
*  1403   89.00 - 89.50    43.00 - 43.50     3.820  .251  166.71      2.071  .000  103.98  *
*  1404   89.00 - 89.50    43.50 - 44.00     3.762  .282  213.45      3.080  .559  237.09  *
*  1405   89.00 - 89.50    44.00 - 44.50     3.762  .282  236.27      3.080  .559  221.69  *
*  1406   89.00 - 89.50    44.50 - 45.00     3.651  .291  222.09      3.080  .559  197.92  *
*  1407   89.00 - 89.50    45.00 - 45.50     3.437  .217  170.61      3.080  .559  169.50  *
*  1408   89.00 - 89.50    45.50 - 46.00     3.437  .217  155.05      3.080  .559  138.51  *
*  1409   89.00 - 89.50    46.00 - 46.50     3.373  .253  120.88      3.074  .553  106.54  *
*  1410   89.00 - 89.50    46.50 - 47.00     3.281  .319   78.46      3.074  .553   73.48  *
*  1411   89.00 - 89.50    47.00 - 47.50     3.200  .322   54.43      3.074  .553   42.76  *
*  1412   89.00 - 89.50    47.50 - 48.00     3.200  .322   71.33      3.074  .553   25.26  *
*  1413   89.00 - 89.50    48.00 - 48.50     3.176  .353  100.02      3.074  .553   42.76  *
*  1414   89.00 - 89.50    48.50 - 49.00     3.176  .353  135.09      3.074  .553   73.48  *
*  1415   89.00 - 89.50    49.00 - 49.50     3.176  .353  171.27      3.074  .553  106.54  *
*  1416   89.00 - 89.50    49.50 - 50.00     3.147  .394  204.42      3.074  .553  140.29  *
*  1417   89.50 - 90.00    28.00 - 28.50     2.622  .061  147.88      2.722  .255  187.52  *
*  1418   89.50 - 90.00    28.50 - 29.00     2.733  .049  130.79      2.722  .255  195.63  *
*  1419   89.50 - 90.00    29.00 - 29.50     2.733  .049  103.14      2.722  .255  207.69  *
*  1420   89.50 - 90.00    29.50 - 30.00     2.942  .072   99.91      2.722  .255  221.41  *
*  1421   89.50 - 90.00    30.00 - 30.50     3.221  .215  112.02      2.722  .255  235.37  *
*  1422   89.50 - 90.00    30.50 - 31.00     3.282  .184  142.38      2.839  .206  256.94  *
*  1423   89.50 - 90.00    31.00 - 31.50     3.561  .152  198.76      2.839  .206  263.07  *
*  1424   89.50 - 90.00    31.50 - 32.00     3.679  .136  203.61      3.207  .184  271.55  *
*  1425   89.50 - 90.00    32.00 - 32.50     3.747  .087  186.11      3.241  .164  241.65  *
*  1426   89.50 - 90.00    32.50 - 33.00     4.615  .804  329.13      3.449  .176  224.55  *
*  1427   89.50 - 90.00    33.00 - 33.50     4.667  .764  295.78      3.728  .213  231.08  *
*  1428   89.50 - 90.00    33.50 - 34.00     4.673  .759  243.10      3.873  .279  218.58  *
*  1429   89.50 - 90.00    34.00 - 34.50     4.702  .737  157.15      3.892  .276  183.84  *
*  1430   89.50 - 90.00    34.50 - 35.00     4.724  .721  164.45      3.892  .276  143.31  *
*  1431   89.50 - 90.00    35.00 - 35.50     4.733  .714  121.56      3.892  .276   95.28  *
*  1432   89.50 - 90.00    35.50 - 36.00     4.733  .714   81.98      3.882  .284   37.57  *
*  1433   89.50 - 90.00    36.00 - 36.50     4.737  .711   52.97      3.882  .284   44.55  *
*  1434   89.50 - 90.00    36.50 - 37.00     4.738  .711   20.36      3.882  .284   30.97  *
*  1435   89.50 - 90.00    37.00 - 37.50     4.737  .712   59.42      3.882  .284   56.88  *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1436	89.50 - 90.00	37.50 - 38.00	4.740	.710	101.70	3.884	.278	64.28
1437	89.50 - 90.00	38.00 - 38.50	4.740	.710	110.66	3.884	.278	53.68
1438	89.50 - 90.00	38.50 - 39.00	4.735	.713	137.10	3.884	.278	108.94
1439	89.50 - 90.00	39.00 - 39.50	4.733	.714	169.95	3.874	.287	147.82
1440	89.50 - 90.00	39.50 - 40.00	4.698	.742	207.04	3.874	.287	183.16
1441	89.50 - 90.00	40.00 - 40.50	4.682	.754	233.88	3.819	.292	206.29
1442	89.50 - 90.00	40.50 - 41.00	4.665	.770	277.84	3.779	.306	226.78
1443	89.50 - 90.00	41.00 - 41.50	3.892	.214	139.99	3.671	.349	216.04
1444	89.50 - 90.00	41.50 - 42.00	3.866	.186	148.75	3.361	.404	142.77
1445	89.50 - 90.00	42.00 - 42.50	3.856	.185	152.18	2.621	.255	90.27
1446	89.50 - 90.00	42.50 - 43.00	3.702	.168	119.58	2.071	.000	74.32
1447	89.50 - 90.00	43.00 - 43.50	3.820	.251	185.08	2.071	.000	107.12
1448	89.50 - 90.00	43.50 - 44.00	3.762	.282	223.18	3.080	.559	239.93
1449	89.50 - 90.00	44.00 - 44.50	3.762	.282	246.50	3.080	.559	224.62
1450	89.50 - 90.00	44.50 - 45.00	3.642	.306	233.94	3.080	.559	201.37
1451	89.50 - 90.00	45.00 - 45.50	3.425	.237	182.31	3.080	.559	173.74
1452	89.50 - 90.00	45.50 - 46.00	3.425	.237	167.43	3.080	.559	143.91
1453	89.50 - 90.00	46.00 - 46.50	3.358	.277	136.81	3.074	.553	113.86
1454	89.50 - 90.00	46.50 - 47.00	3.260	.349	100.24	3.074	.553	83.75
1455	89.50 - 90.00	47.00 - 47.50	3.176	.353	80.93	3.074	.553	58.67
1456	89.50 - 90.00	47.50 - 48.00	3.176	.353	91.56	3.074	.553	47.46
1457	89.50 - 90.00	48.00 - 48.50	3.176	.353	116.03	3.074	.553	58.67
1458	89.50 - 90.00	48.50 - 49.00	3.176	.353	146.71	3.074	.553	83.75
1459	89.50 - 90.00	49.00 - 49.50	3.176	.353	179.99	3.074	.553	113.86
1460	89.50 - 90.00	49.50 - 50.00	3.147	.394	211.16	3.074	.553	145.93
1461	90.00 - 90.50	28.00 - 28.50	2.622	.061	141.24	2.722	.255	155.45
1462	90.00 - 90.50	28.50 - 29.00	2.733	.049	124.02	2.722	.255	166.85
1463	90.00 - 90.50	29.00 - 29.50	2.733	.049	96.24	2.722	.255	182.30
1464	90.00 - 90.50	29.50 - 30.00	2.942	.072	96.54	2.722	.255	198.38
1465	90.00 - 90.50	30.00 - 30.50	3.221	.215	119.77	2.722	.255	213.29
1466	90.00 - 90.50	30.50 - 31.00	3.282	.184	139.21	2.839	.206	236.28
1467	90.00 - 90.50	31.00 - 31.50	3.548	.171	193.48	2.839	.206	242.39
1468	90.00 - 90.50	31.50 - 32.00	3.670	.151	203.38	3.207	.184	262.18
1469	90.00 - 90.50	32.00 - 32.50	3.739	.094	188.49	3.241	.164	236.23
1470	90.00 - 90.50	32.50 - 33.00	4.612	.807	332.03	3.449	.176	221.78

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                         * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2      LAT1 - LAT2          A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

  1471    90.00 -  90.50     33.00 - 33.50        4.664   .767   298.29       3.728   .213   228.68
  1472    90.00 -  90.50     33.50 - 34.00        4.671   .762   249.67       3.873   .279   217.11
  1473    90.00 -  90.50     34.00 - 34.50        4.700   .739   203.85       3.892   .276   183.25
  1474    90.00 -  90.50     34.50 - 35.00        4.722   .723   159.47       3.892   .276   144.39
  1475    90.00 -  90.50     35.00 - 35.50        4.731   .716    77.96       3.892   .276   101.28
  1476    90.00 -  90.50     35.50 - 36.00        4.731   .716    74.09       3.882   .284    55.79
  1477    90.00 -  90.50     36.00 - 36.50        4.735   .713    73.42       3.882   .284    61.33
  1478    90.00 -  90.50     36.50 - 37.00        4.740   .709    51.17       3.882   .284    42.58
  1479    90.00 -  90.50     37.00 - 37.50        4.739   .710    77.25       3.882   .284    60.13
  1480    90.00 -  90.50     37.50 - 38.00        4.743   .708   109.16       3.886   .278    61.09
  1481    90.00 -  90.50     38.00 - 38.50        4.742   .708    89.58       3.886   .278    83.09
  1482    90.00 -  90.50     38.50 - 39.00        4.735   .713    87.52       3.886   .278   114.39
  1483    90.00 -  [illegible] 39.00 - 39.50      4.733   .714   122.99       3.876   .287   149.10
  1484    90.00 -  90.50     39.50 - 40.00        4.698   .742   199.35       3.876   .287   183.74
  1485    90.00 -  90.50     40.00 - 40.50        4.682   .753   170.28       3.815   .292   207.14
  1486    90.00 -  90.50     40.50 - 41.00        4.666   .769   271.69       3.779   .306   230.31
  1487    90.00 -  90.50     41.00 - 41.50        3.895   .212   137.54       3.671   .349   235.52
  1488    90.00 -  90.50     41.50 - 42.00        3.870   .181   134.27       3.361   .404   204.06
  1489    90.00 -  90.50     42.00 - 42.50        3.860   .179   160.43       2.621   .255   120.70
  1490    90.00 -  90.50     42.50 - 43.00        3.708   .160   159.59       2.071   .000    86.67
  1491    90.00 -  90.50     43.00 - 43.50        3.594   .167   170.14       2.071   .000   116.03
  1492    90.00 -  90.50     43.50 - 44.00        3.493   .210   186.05       3.080   .559   245.69
  1493    90.00 -  90.50     44.00 - 44.50        3.493   .210   203.38       3.080   .559   229.88
  1494    90.00 -  90.50     44.50 - 45.00        3.425   .237   199.82       3.080   .559   207.16
  1495    90.00 -  90.50     45.00 - 45.50        3.425   .237   194.32       3.080   .559   180.65
  1496    90.00 -  90.50     45.50 - 46.00        3.425   .237   182.07       3.080   .559   152.47
  1497    90.00 -  90.50     46.00 - 46.50        3.358   .277   156.70       3.074   .553   125.12
  1498    90.00 -  90.50     46.50 - 47.00        3.260   .349   124.76       3.074   .553    98.51
  1499    90.00 -  90.50     47.00 - 47.50        3.176   .353   107.24       3.074   .553    78.31
  1500    90.00 -  90.50     47.50 - 48.00        3.176   .353   115.19       3.074   .553    70.30
  1501    90.00 -  90.50     48.00 - 48.50        3.176   .353   134.75       3.074   .553    78.31
  1502    90.00 -  90.50     48.50 - 49.00        3.176   .353   161.20       3.074   .553    98.51
  1503    90.00 -  90.50     49.00 - 49.50        3.176   .353   191.33       3.074   .553   125.12
  1504    90.00 -  90.50     49.50 - 50.00        3.147   .394   220.24       3.074   .553   154.88
  1505    90.50 -  91.00     28.00 - 28.50        2.890   .122   180.98       2.722   .255   122.94
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                          * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    D(H)     R(H)        A(N)    D(N)     R(N)

  1506    90.50 -  91.00    28.50 - 29.00      2.942    .072   148.87       2.722    .255   139.20
  1507    90.50 -  91.00    29.00 - 29.50      2.942    .072   112.11       2.722    .255   159.10
  1508    90.50 -  91.00    29.50 - 30.00      3.119    .160    94.93       2.722    .255   177.70
  1509    90.50 -  91.00    30.00 - 30.50      3.379    .197    95.36       2.722    .255   192.97
  1510    90.50 -  91.00    30.50 - 31.00      3.420    .179   132.47       2.839    .206   216.30
  1511    90.50 -  91.00    31.00 - 31.50      3.612    .160   192.25       2.839    .206   221.87
  1512    90.50 -  91.00    31.50 - 32.00      3.715    .154   205.53       3.207    .184   252.87
  1513    90.50 -  91.00    32.00 - 32.50      3.777    .113   192.65       3.241    .164   231.70
  1514    90.50 -  91.00    32.50 - 33.00      4.624    .797   337.90       3.449    .176   220.81
  1515    90.50 -  91.00    33.00 - 33.50      4.675    .759   306.27       3.728    .213   228.77
  1516    90.50 -  91.00    33.50 - 34.00      4.680    .754   262.13       3.873    .279   218.83
  1517    90.50 -  91.00    34.00 - 34.50      4.704    .737   221.78       3.892    .276   187.03
  1518    90.50 -  91.00    34.50 - 35.00      4.725    .721   178.31       3.892    .276   152.24
  1519    90.50 -  91.00    35.00 - 35.50      4.734    .714   135.80       3.892    .276   117.66
  1520    90.50 -  91.00    35.50 - 36.00      4.734    .714   116.64       3.882    .284    87.56
  1521    90.50 -  91.00    36.00 - 36.50      4.736    .713    98.42       3.882    .284    58.19
  1522    90.50 -  91.00    36.50 - 37.00      4.740    .710    92.81       3.882    .284    61.47
  1523    90.50 -  91.00    37.00 - 37.50      4.739    .711    97.14       3.882    .284    45.35
  1524    90.50 -  91.00    37.50 - 38.00      4.742    .708   126.56       3.884    .278    63.03
  1525    90.50 -  91.00    38.00 - 38.50      4.739    .711   117.09       3.884    .278    89.57
  1526    90.50 -  91.00    38.50 - 39.00      4.732    .716   134.19       3.884    .278   121.60
  1527    90.50 -  91.00    39.00 - 39.50      4.730    .717   176.31       3.876    .287   153.94
  1528    90.50 -  91.00    39.50 - 40.00      4.696    .744   213.38       3.876    .287   187.67
  1529    90.50 -  91.00    40.00 - 40.50      4.680    .755   233.40       3.815    .292   211.00
  1530    90.50 -  91.00    40.50 - 41.00      4.665    .770   281.75       3.779    .306   236.12
  1531    90.50 -  91.00    41.00 - 41.50      3.891    .207   136.14       3.671    .349   249.44
  1532    90.50 -  91.00    41.50 - 42.00      3.864    .174    75.19       3.361    .404   237.44
  1533    90.50 -  91.00    42.00 - 42.50      3.854    .172   161.31       2.621    .255   151.93
  1534    90.50 -  91.00    42.50 - 43.00      3.698    .150   178.60       2.071    .000   104.04
  1535    90.50 -  91.00    43.00 - 43.50      3.616    .153   191.02       2.071    .000   129.52
  1536    90.50 -  91.00    43.50 - 44.00      3.525    .184   202.81       3.080    .559   253.89
  1537    90.50 -  91.00    44.00 - 44.50      3.525    .184   216.71       3.080    .559   237.28
  1538    90.50 -  91.00    44.50 - 45.00      3.437    .217   210.69       3.080    .559   215.11
  1539    90.50 -  91.00    45.00 - 45.50      3.437    .217   206.75       3.080    .559   189.91
  1540    90.50 -  91.00    45.50 - 46.00      3.437    .217   197.68       3.080    .559   163.66
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                              *
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*   GFID     LONG1 - LONG2     LAT1 - LAT2        A(H)    Q(H)    R(H)        A(N)    Q(N)    R(N)  *
*****************************************************************************************************
*                                                                                                   *
*   1541     90.50 -  91.00    46.00 - 46.50      3.373   .253   178.30       3.074   .553   139.36 *
*   1542     90.50 -  91.00    46.50 - 47.00      3.281   .319   150.97       3.074   .553   116.06 *
*   1543     90.50 -  91.00    47.00 - 47.50      3.200   .322   134.96       3.074   .553    99.50 *
*   1544     90.50 -  91.00    47.50 - 48.00      3.176   .353   138.15       3.074   .553    93.32 *
*   1545     90.50 -  91.00    48.00 - 48.50      3.176   .353   154.34       3.074   .553    99.50 *
*   1546     90.50 -  91.00    48.50 - 49.00      3.176   .353   177.26       3.074   .553   116.06 *
*   1547     90.50 -  91.00    49.00 - 49.50      3.176   .353   204.45       3.074   .553   139.36 *
*   1548     90.50 -  91.00    49.50 - 50.00      3.147   .394   231.11       3.074   .553   166.59 *
*   1549     91.00 -  91.50    28.00 - 28.50      2.890   .122   179.52       2.722   .255    90.62 *
*   1550     91.00 -  91.50    28.50 - 29.00      2.942   .072   147.19       2.722   .255   114.16 *
*   1551     91.00 -  91.50    29.00 - 29.50      2.942   .072   107.27       2.722   .255   139.46 *
*   1552     91.00 -  91.50    29.50 - 30.00      2.980   .071    63.45       2.722   .255   160.19 *
*   1553     91.00 -  91.50    30.00 - 30.50      3.232   .080    27.38       2.722   .255   174.53 *
*   1554     91.00 -  91.50    30.50 - 31.00      3.283   .059    92.12       2.839   .206   196.48 *
*   1555     91.00 -  91.50    31.00 - 31.50      3.551   .112   175.92       2.839   .206   200.68 *
*   1556     91.00 -  91.50    31.50 - 32.00      3.669   .113   196.74       3.207   .184   242.52 *
*   1557     91.00 -  91.50    32.00 - 32.50      3.732   .080   185.32       3.241   .164   227.22 *
*   1558     91.00 -  91.50    32.50 - 33.00      4.612   .806   340.65       3.449   .176   221.07 *
*   1559     91.00 -  91.50    33.00 - 33.50      4.665   .765   311.16       3.728   .213   230.73 *
*   1560     91.00 -  91.50    33.50 - 34.00      4.671   .761   270.41       3.873   .279   222.51 *
*   1561     91.00 -  91.50    34.00 - 34.50      4.695   .742   235.06       3.892   .276   192.79 *
*   1562     91.00 -  91.50    34.50 - 35.00      4.718   .725   201.54       3.892   .276   162.32 *
*   1563     91.00 -  91.50    35.00 - 35.50      4.728   .718   171.85       3.892   .276   134.53 *
*   1564     91.00 -  91.50    35.50 - 36.00      4.728   .718   149.52       3.882   .284   108.56 *
*   1565     91.00 -  91.50    36.00 - 36.50      4.729   .716   133.22       3.882   .284    87.40 *
*   1566     91.00 -  91.50    36.50 - 37.00      4.738   .711   130.03       3.882   .284    66.56 *
*   1567     91.00 -  91.50    37.00 - 37.50      4.737   .712   136.23       3.882   .284    26.22 *
*   1568     91.00 -  91.50    37.50 - 38.00      4.740   .710   153.12       3.884   .278    39.88 *
*   1569     91.00 -  91.50    38.00 - 38.50      4.735   .713   164.10       3.884   .278    90.60 *
*   1570     91.00 -  91.50    38.50 - 39.00      4.728   .718   181.78       3.884   .278   128.99 *
*   1571     91.00 -  91.50    39.00 - 39.50      4.727   .719   212.15       3.874   .287   161.60 *
*   1572     91.00 -  91.50    39.50 - 40.00      4.693   .746   235.56       3.874   .287   194.67 *
*   1573     91.00 -  91.50    40.00 - 40.50      4.676   .757   216.69       3.815   .292   217.62 *
*   1574     91.00 -  91.50    40.50 - 41.00      4.660   .773   296.38       3.779   .306   243.68 *
*   1575     91.00 -  91.50    41.00 - 41.50      3.881   .200   148.25       3.671   .349   260.60 *
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                           *
**************************************************************************************************
*   GRID     LONG1 - LONG2     LAT1 - LAT2          A(H)    C(H)    R(H)        A(N)   B(N)   R(N)   *
**************************************************************************************************
*                                                                                                *
*   1576     91.00 -  91.50     41.50 - 42.00       3.848   .165   142.14      3.361   .404  259.40  *
*   1577     91.00 -  91.50     42.00 - 42.50       3.837   .164   178.54      2.621   .255  180.18  *
*   1578     91.00 -  91.50     42.50 - 43.00       3.704   .143   195.85      2.071   .000  124.34  *
*   1579     91.00 -  91.50     43.00 - 43.50       3.671   .166   218.48      2.071   .000  146.33  *
*   1580     91.00 -  91.50     43.50 - 44.00       3.540   .208   221.33      3.080   .559  263.99  *
*   1581     91.00 -  91.50     44.00 - 44.50       3.502   .194   224.73      3.080   .559  246.58  *
*   1582     91.00 -  91.50     44.50 - 45.00       3.408   .233   217.61      3.080   .559  224.99  *
*   1583     91.00 -  91.50     45.00 - 45.50       3.408   .233   213.74      3.080   .559  201.19  *
*   1584     91.00 -  91.50     45.50 - 46.00       3.408   .233   206.39      3.080   .559  176.97  *
*   1585     91.00 -  91.50     46.00 - 46.50       3.333   .281   188.40      3.074   .553  155.77  *
*   1586     91.00 -  91.50     46.50 - 47.00       3.281   .319   171.23      3.074   .553  135.33  *
*   1587     91.00 -  91.50     47.00 - 47.50       3.200   .322   156.59      3.074   .553  121.42  *
*   1588     91.00 -  91.50     47.50 - 48.00       3.176   .353   159.39      3.074   .553  116.41  *
*   1589     91.00 -  91.50     48.00 - 48.50       3.176   .353   173.51      3.074   .553  121.42  *
*   1590     91.00 -  91.50     48.50 - 49.00       3.176   .353   193.83      3.074   .553  135.33  *
*   1591     91.00 -  91.50     49.00 - 49.50       3.176   .353   218.57      3.074   .553  155.77  *
*   1592     91.00 -  91.50     49.50 - 50.00       3.147   .394   243.19      3.074   .553  180.54  *
*   1593     91.50 -  92.00     28.00 - 28.50       2.989   .115   198.07      2.722   .255   61.53  *
*   1594     91.50 -  92.00     28.50 - 29.00       3.034   .054   166.22      2.722   .255   95.03  *
*   1595     91.50 -  92.00     29.00 - 29.50       3.034   .054   127.57      2.722   .255  125.35  *
*   1596     91.50 -  92.00     29.50 - 30.00       3.068   .021    88.93      2.722   .255  146.61  *
*   1597     91.50 -  92.00     30.00 - 30.50       3.283   .059    83.93      2.722   .255  157.72  *
*   1598     91.50 -  92.00     30.50 - 31.00       3.325   .067   116.86      2.839   .206  175.68  *
*   1599     91.50 -  92.00     31.00 - 31.50       3.571   .105   183.17      2.839   .206  177.26  *
*   1600     91.50 -  92.00     31.50 - 32.00       3.681   .117   198.39      3.207   .184  229.31  *
*   1601     91.50 -  92.00     32.00 - 32.50       3.741   .090   186.69      3.241   .164  221.68  *
*   1602     91.50 -  92.00     32.50 - 33.00       4.615   .803   347.89      3.449   .176  222.03  *
*   1603     91.50 -  92.00     33.00 - 33.50       4.668   .763   317.62      3.728   .213  233.99  *
*   1604     91.50 -  92.00     33.50 - 34.00       4.673   .758   274.23      3.873   .279  226.73  *
*   1605     91.50 -  92.00     34.00 - 34.50       4.697   .740   246.95      3.892   .276  196.77  *
*   1606     91.50 -  92.00     34.50 - 35.00       4.719   .724   216.97      3.892   .276  169.08  *
*   1607     91.50 -  92.00     35.00 - 35.50       4.729   .717   199.85      3.892   .276  148.61  *
*   1608     91.50 -  92.00     35.50 - 36.00       4.729   .717   180.62      3.882   .284  127.48  *
*   1609     91.50 -  92.00     36.00 - 36.50       4.730   .716   152.75      3.882   .284  107.51  *
*   1610     91.50 -  92.00     36.50 - 37.00       4.740   .709   164.64      3.882   .284   83.96  *
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *                                  *
*****************************************************************************************************
*   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)   B(H)    R(H)        A(N)   B(N)    R(N)    *
*****************************************************************************************************
*                                                                                                   *
*   1611    91.50 -  92.00     37.00 - 37.50     4.739   .710   168.98      3.882   .284    62.83   *
*   1612    91.50 -  92.00     37.50 - 38.00     4.742   .708   183.44      3.886   .278    74.10   *
*   1613    91.50 -  92.00     38.00 - 38.50     4.741   .709   199.64      3.886   .278   105.66   *
*   1614    91.50 -  92.00     38.50 - 39.00     4.738   .711   219.19      3.886   .278   141.05   *
*   1615    91.50 -  92.00     39.00 - 39.50     4.737   .712   245.02      3.876   .287   172.66   *
*   1616    91.50 -  92.00     39.50 - 40.00     4.704   .739   263.91      3.876   .287   204.72   *
*   1617    91.50 -  92.00     40.00 - 40.50     4.688   .749   283.75      3.815   .292   226.89   *
*   1618    91.50 -  92.00     40.50 - 41.00     4.673   .764   322.21      3.779   .306   253.10   *
*   1619    91.50 -  92.00     41.00 - 41.50     3.915   .215   170.83      3.671   .349   271.42   *
*   1620    91.50 -  92.00     41.50 - 42.00     3.908   .165   195.11      3.361   .404   277.05   *
*   1621    91.50 -  92.00     42.00 - 42.50     3.898   .165   216.47      2.621   .255   205.51   *
*   1622    91.50 -  92.00     42.50 - 43.00     3.784   .148   229.20      2.071   .000   146.37   *
*   1623    91.50 -  92.00     43.00 - 43.50     3.693   .169   230.89      2.071   .000   165.45   *
*   1624    91.50 -  92.00     43.50 - 44.00     3.573   .198   233.71      3.080   .559   275.55   *
*   1625    91.50 -  92.00     44.00 - 44.50     3.541   .182   236.93      3.080   .559   257.53   *
*   1626    91.50 -  92.00     44.50 - 45.00     3.458   .209   232.47      3.080   .559   236.57   *
*   1627    91.50 -  92.00     45.00 - 45.50     3.458   .209   229.52      3.080   .559   214.18   *
*   1628    91.50 -  92.00     45.50 - 46.00     3.398   .214   212.40      3.080   .559   191.93   *
*   1629    91.50 -  92.00     46.00 - 46.50     3.314   .277   195.12      3.074   .553   173.73   *
*   1630    91.50 -  92.00     46.50 - 47.00     3.314   .277   191.61      3.074   .553   155.67   *
*   1631    91.50 -  92.00     47.00 - 47.50     3.200   .322   174.36      3.074   .553   143.74   *
*   1632    91.50 -  92.00     47.50 - 48.00     3.176   .353   178.00      3.074   .553   139.54   *
*   1633    91.50 -  92.00     48.00 - 48.50     3.176   .353   191.33      3.074   .553   143.74   *
*   1634    91.50 -  92.00     48.50 - 49.00     3.176   .353   210.07      3.074   .553   155.67   *
*   1635    91.50 -  92.00     49.00 - 49.50     3.176   .353   233.02      3.074   .553   173.73   *
*   1636    91.50 -  92.00     49.50 - 50.00     3.147   .394   256.02      3.074   .553   196.25   *
*   1637    92.00 -  92.50     28.00 - 28.50     2.989   .115   204.17      2.722   .255    47.27   *
*   1638    92.00 -  92.50     28.50 - 29.00     3.034   .054   176.50      2.722   .255    87.17   *
*   1639    92.00 -  92.50     29.00 - 29.50     3.034   .054   145.05      2.722   .255   118.70   *
*   1640    92.00 -  92.50     29.50 - 30.00     3.068   .021   119.42      2.722   .255   137.28   *
*   1641    92.00 -  92.50     30.00 - 30.50     3.283   .059   135.32      2.722   .255   141.84   *
*   1642    92.00 -  92.50     30.50 - 31.00     3.325   .067   147.34      2.839   .206   151.96   *
*   1643    92.00 -  92.50     31.00 - 31.50     3.571   .105   193.34      2.839   .206   149.05   *
*   1644    92.00 -  92.50     31.50 - 32.00     3.681   .117   201.36      3.207   .184   210.30   *
*   1645    92.00 -  92.50     32.00 - 32.50     3.741   .090   188.74      3.241   .164   213.83   *
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                            * SEISMIC MAP OF CONTINENTAL U.S. *
 GRID   LONG1 - LONG2    LAT1 - LAT2       A(H)    C(H)    R(H)        A(N)   C(N)    R(N)

 1646   92.00 - 92.50    32.50 - 33.00     4.615   .803   357.14      3.449   .176   223.41
 1647   92.00 - 92.50    33.00 - 33.50     4.668   .763   323.89      3.728   .213   238.59
 1648   92.00 - 92.50    33.50 - 34.00     4.673   .758   230.52      3.873   .279   231.03
 1649   92.00 - 92.50    34.00 - 34.50     4.697   .740   255.11      3.892   .276   193.45
 1650   92.00 - 92.50    34.50 - 35.00     4.714   .728   179.10      3.892   .276   156.50
 1651   92.00 - 92.50    35.00 - 35.50     4.730   .716   223.74      3.892   .276   156.91
 1652   92.00 - 92.50    35.50 - 36.00     4.734   .714   213.22      3.882   .284   145.45
 1653   92.00 - 92.50    36.00 - 36.50     4.735   .713   200.20      3.882   .284   128.70
 1654   92.00 - 92.50    36.50 - 37.00     4.741   .708   197.95      3.882   .284   111.08
 1655   92.00 - 92.50    37.00 - 37.50     4.744   .707   180.28      3.882   .284   100.57
 1656   92.00 - 92.50    37.50 - 38.00     4.748   .704   214.58      3.886   .278   108.07
 1657   92.00 - 92.50    38.00 - 38.50     4.746   .706   231.97      3.884   .278   129.96
 1658   92.00 - 92.50    38.50 - 39.00     4.745   .707   251.67      3.886   .278   158.68
 1659   92.00 - 92.50    39.00 - 39.50     4.744   .707   274.94      3.874   .287   187.46
 1660   92.00 - 92.50    39.50 - 40.00     4.709   .735   291.16      3.874   .287   217.80
 1661   92.00 - 92.50    40.00 - 40.50     4.694   .745   316.21      3.815   .292   238.71
 1662   92.00 - 92.50    40.50 - 41.00     4.679   .759   346.57      3.779   .306   264.49
 1663   92.00 - 92.50    41.00 - 41.50     3.931   .222   187.12      3.671   .349   283.06
 1664   92.00 - 92.50    41.50 - 42.00     3.936   .164   221.18      3.361   .404   293.38
 1665   92.00 - 92.50    42.00 - 42.50     3.926   .164   237.94      2.621   .255   228.78
 1666   92.00 - 92.50    42.50 - 43.00     3.820   .150   245.53      2.071   .000   169.44
 1667   92.00 - 92.50    43.00 - 43.50     3.708   .165   238.98      2.071   .000   186.18
 1668   92.00 - 92.50    43.50 - 44.00     3.594   .188   240.59      3.080   .559   288.26
 1669   92.00 - 92.50    44.00 - 44.50     3.563   .171   242.49      3.080   .559   269.87
 1670   92.00 - 92.50    44.50 - 45.00     3.486   .192   238.90      3.080   .559   249.60
 1671   92.00 - 92.50    45.00 - 45.50     3.486   .192   235.94      3.080   .559   228.58
 1672   92.00 - 92.50    45.50 - 46.00     3.430   .196   220.98      3.080   .559   208.16
 1673   92.00 - 92.50    46.00 - 46.50     3.361   .240   209.41      3.074   .553   192.82
 1674   92.00 - 92.50    46.50 - 47.00     3.361   .240   209.76      3.074   .553   176.71
 1675   92.00 - 92.50    47.00 - 47.50     3.200   .322   187.06      3.074   .553   166.30
 1676   92.00 - 92.50    47.50 - 48.00     3.176   .353   193.15      3.074   .553   162.68
 1677   92.00 - 92.50    48.00 - 48.50     3.176   .353   207.09      3.074   .553   166.30
 1678   92.00 - 92.50    48.50 - 49.00     3.176   .353   225.38      3.074   .553   176.71
 1679   92.00 - 92.50    49.00 - 49.50     3.176   .353   247.34      3.074   .553   192.82
 1680   92.00 - 92.50    49.50 - 50.00     3.147   .394   269.18      3.074   .553   213.33
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• SEISMIC MAP OF CONTINENTAL U.S. •

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	O(H)	R(H)	A(N)	O(N)	R(N)
1681	92.50 - 93.00	28.00 - 28.50	2.989	.115	212.30	2.722	.255	61.23
1682	92.50 - 93.00	28.50 - 29.00	3.013	.082	186.70	2.722	.255	93.49
1683	92.50 - 93.00	29.00 - 29.50	3.013	.082	161.22	2.722	.255	119.87
1684	92.50 - 93.00	29.50 - 30.00	3.052	.032	142.89	2.722	.255	131.89
1685	92.50 - 93.00	30.00 - 30.50	3.272	.075	164.87	2.722	.255	126.37
1686	92.50 - 93.00	30.50 - 31.00	3.314	.082	166.03	2.839	.206	123.27
1687	92.50 - 93.00	31.00 - 31.50	3.583	.111	202.71	2.839	.206	112.54
1688	92.50 - 93.00	31.50 - 32.00	3.689	.126	204.48	3.207	.184	181.51
1689	92.50 - 93.00	32.00 - 32.50	3.748	.100	191.52	3.241	.164	202.89
1690	92.50 - 93.00	32.50 - 33.00	4.618	.801	369.55	3.449	.176	225.48
1691	92.50 - 93.00	33.00 - 33.50	4.670	.761	341.76	3.728	.213	245.48
1692	92.50 - 93.00	33.50 - 34.00	4.670	.761	297.02	3.877	.279	238.33
1693	92.50 - 93.00	34.00 - 34.50	4.689	.747	270.42	3.892	.276	189.36
1694	92.50 - 93.00	34.50 - 35.00	4.701	.738	250.75	3.892	.276	88.15
1695	92.50 - 93.00	35.00 - 35.50	4.713	.728	248.89	3.892	.276	162.34
1696	92.50 - 93.00	35.50 - 36.00	4.718	.726	241.69	3.882	.284	164.18
1697	92.50 - 93.00	36.00 - 36.50	4.719	.724	233.39	3.882	.284	152.05
1698	92.50 - 93.00	36.50 - 37.00	4.744	.706	232.89	3.882	.284	139.75
1699	92.50 - 93.00	37.00 - 37.50	4.747	.705	233.56	3.882	.284	133.96
1700	92.50 - 93.00	37.50 - 38.00	4.750	.703	246.98	3.886	.278	140.09
1701	92.50 - 93.00	38.00 - 38.50	4.749	.704	263.11	3.886	.278	156.64
1702	92.50 - 93.00	38.50 - 39.00	4.749	.704	281.59	3.886	.278	180.07
1703	92.50 - 93.00	39.00 - 39.50	4.748	.704	302.72	3.874	.287	205.54
1704	92.50 - 93.00	39.50 - 40.00	4.709	.735	315.77	3.874	.287	233.64
1705	92.50 - 93.00	40.00 - 40.50	4.690	.748	339.33	3.815	.292	252.93
1706	92.50 - 93.00	40.50 - 41.00	4.676	.762	367.68	3.779	.306	277.85
1707	92.50 - 93.00	41.00 - 41.50	3.921	.218	197.76	3.671	.349	296.00
1708	92.50 - 93.00	41.50 - 42.00	3.918	.165	230.96	3.361	.404	309.71
1709	92.50 - 93.00	42.00 - 42.50	3.908	.165	244.97	2.621	.255	250.81
1710	92.50 - 93.00	42.50 - 43.00	3.798	.148	247.24	2.071	.000	193.19
1711	92.50 - 93.00	43.00 - 43.50	3.733	.161	241.34	2.071	.000	208.03
1712	92.50 - 93.00	43.50 - 44.00	3.629	.174	241.17	3.080	.559	301.92
1713	92.50 - 93.00	44.00 - 44.50	3.600	.157	241.49	3.080	.559	283.43
1714	92.50 - 93.00	44.50 - 45.00	3.533	.170	238.17	3.080	.559	263.86
1715	92.50 - 93.00	45.00 - 45.50	3.533	.170	234.40	3.080	.559	244.15

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1716	92.50 - 93.00	45.50 - 46.00	3.481	.174	219.70	3.080	.559	225.39
1717	92.50 - 93.00	46.00 - 46.50	3.430	.196	212.75	3.074	.553	212.72
1718	92.50 - 93.00	46.50 - 47.00	3.430	.196	217.94	3.074	.553	198.24
1719	92.50 - 93.00	47.00 - 47.50	3.307	.250	209.97	3.074	.553	189.02
1720	92.50 - 93.00	47.50 - 48.00	3.291	.275	223.54	3.074	.553	185.84
1721	92.50 - 93.00	48.00 - 48.50	3.291	.275	240.92	3.074	.553	189.02
1722	92.50 - 93.00	48.50 - 49.00	3.176	.353	239.43	3.074	.553	198.24
1723	92.50 - 93.00	49.00 - 49.50	3.176	.353	261.22	3.074	.553	212.72
1724	92.50 - 93.00	49.50 - 50.00	3.147	.394	282.43	3.074	.553	231.48
1725	93.00 - 93.50	28.00 - 28.50	2.989	.115	220.69	2.722	.255	89.12
1726	93.00 - 93.50	28.50 - 29.00	2.989	.115	195.37	2.722	.255	109.73
1727	93.00 - 93.50	29.00 - 29.50	2.989	.115	173.04	2.722	.255	127.05
1728	93.00 - 93.50	29.50 - 30.00	3.034	.054	156.98	2.722	.255	130.22
1729	93.00 - 93.50	30.00 - 30.50	3.259	.092	178.36	2.722	.255	113.20
1730	93.00 - 93.50	30.50 - 31.00	3.303	.097	172.43	2.839	.206	91.35
1731	93.00 - 93.50	31.00 - 31.50	3.617	.128	209.83	2.839	.206	64.96
1732	93.00 - 93.50	31.50 - 32.00	3.736	.146	208.86	3.207	.184	142.68
1733	93.00 - 93.50	32.00 - 32.50	3.790	.123	196.55	3.241	.164	191.22
1734	93.00 - 93.50	32.50 - 33.00	4.631	.791	382.97	3.449	.176	229.36
1735	93.00 - 93.50	33.00 - 33.50	4.680	.754	361.17	3.728	.213	255.81
1736	93.00 - 93.50	33.50 - 34.00	4.680	.754	320.60	3.834	.258	244.77
1737	93.00 - 93.50	34.00 - 34.50	4.698	.740	238.46	3.854	.257	206.75
1738	93.00 - 93.50	34.50 - 35.00	4.710	.732	281.03	3.854	.257	168.04
1739	93.00 - 93.50	35.00 - 35.50	4.721	.723	274.84	3.854	.257	180.04
1740	93.00 - 93.50	35.50 - 36.00	4.725	.721	269.94	3.843	.265	179.46
1741	93.00 - 93.50	36.00 - 36.50	4.726	.719	265.83	3.843	.265	170.71
1742	93.00 - 93.50	36.50 - 37.00	4.730	.717	264.75	3.882	.284	168.30
1743	93.00 - 93.50	37.00 - 37.50	4.734	.714	268.85	3.882	.284	165.09
1744	93.00 - 93.50	37.50 - 38.00	4.737	.711	278.31	3.886	.278	170.64
1745	93.00 - 93.50	38.00 - 38.50	4.736	.713	292.25	3.886	.278	184.00
1746	93.00 - 93.50	38.50 - 39.00	4.736	.713	309.06	3.886	.278	203.62
1747	93.00 - 93.50	39.00 - 39.50	4.735	.713	328.17	3.876	.287	226.10
1748	93.00 - 93.50	39.50 - 40.00	4.694	.745	338.44	3.876	.287	251.84
1749	93.00 - 93.50	40.00 - 40.50	4.675	.759	360.00	3.815	.292	269.29
1750	93.00 - 93.50	40.50 - 41.00	4.658	.775	385.00	3.779	.306	293.08

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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                                    *
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*   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    Q(H)    R(H)        A(N)   Q(N)    R(N)   *
***************************************************************************************************
*                                                                                                 *
*   1751    93.00 -  93.50    41.00 - 41.50      3.875   .204   202.79      3.671   .349   310.43   *
*   1752    93.00 -  93.50    41.50 - 42.00      3.840   .172   226.04      3.361   .404   326.65   *
*   1753    93.00 -  93.50    42.00 - 42.50      3.851   .172   240.01      2.621   .255   272.20   *
*   1754    93.00 -  93.50    42.50 - 43.00      3.753   .156   238.38      2.071   .000   217.40   *
*   1755    93.00 -  93.50    43.00 - 43.50      3.729   .167   241.14      2.071   .000   230.68   *
*   1756    93.00 -  93.50    43.50 - 44.00      3.629   .174   239.25      3.080   .559   316.40   *
*   1757    93.00 -  93.50    44.00 - 44.50      3.600   .157   239.07      3.080   .559   298.00   *
*   1758    93.00 -  93.50    44.50 - 45.00      3.533   .170   234.19      3.080   .559   279.18   *
*   1759    93.00 -  93.50    45.00 - 45.50      3.533   .170   227.43      3.080   .559   260.67   *
*   1760    93.00 -  93.50    45.50 - 46.00      3.481   .174   207.57      3.080   .559   243.40   *
*   1761    93.00 -  93.50    46.00 - 46.50      3.430   .196   196.12      3.074   .553   233.23   *
*   1762    93.00 -  93.50    46.50 - 47.00      3.430   .196   206.90      3.074   .553   220.10   *
*   1763    93.00 -  93.50    47.00 - 47.50      3.307   .250   207.92      3.074   .553   211.84   *
*   1764    93.00 -  93.50    47.50 - 48.00      3.291   .275   228.61      3.074   .553   209.01   *
*   1765    93.00 -  93.50    48.00 - 48.50      3.291   .275   249.87      3.074   .553   211.84   *
*   1766    93.00 -  93.50    48.50 - 49.00      3.176   .353   252.19      3.074   .553   220.10   *
*   1767    93.00 -  93.50    49.00 - 49.50      3.176   .353   274.59      3.074   .553   233.23   *
*   1768    93.00 -  93.50    49.50 - 50.00      3.147   .394   295.64      3.074   .553   250.46   *
*   1769    93.50 -  94.00    28.00 - 28.50      2.989   .115   228.27      2.722   .255   118.61   *
*   1770    93.50 -  94.00    28.50 - 29.00      2.989   .115   204.03      2.722   .255   129.86   *
*   1771    93.50 -  94.00    29.00 - 29.50      2.989   .115   182.20      2.722   .255   138.10   *
*   1772    93.50 -  94.00    29.50 - 30.00      3.034   .054   164.24      2.722   .255   133.30   *
*   1773    93.50 -  94.00    30.00 - 30.50      3.259   .092   181.70      2.722   .255   108.53   *
*   1774    93.50 -  94.00    30.50 - 31.00      3.303   .097   169.08      2.839   .206    73.70   *
*   1775    93.50 -  94.00    31.00 - 31.50      3.617   .128   200.78      2.839   .206    21.99   *
*   1776    93.50 -  94.00    31.50 - 32.00      3.749   .146   199.79      3.207   .184   118.58   *
*   1777    93.50 -  94.00    32.00 - 32.50      3.800   .129   190.75      3.241   .164   187.85   *
*   1778    93.50 -  94.00    32.50 - 33.00      4.633   .789   390.94      3.449   .176   237.20   *
*   1779    93.50 -  94.00    33.00 - 33.50      4.682   .753   375.30      3.721   .221   270.02   *
*   1780    93.50 -  94.00    33.50 - 34.00      4.682   .753   341.56      3.829   .265   264.49   *
*   1781    93.50 -  94.00    34.00 - 34.50      4.700   .739   311.81      3.849   .263   239.26   *
*   1782    93.50 -  94.00    34.50 - 35.00      4.711   .731   298.28      3.849   .263   217.68   *
*   1783    93.50 -  94.00    35.00 - 35.50      4.722   .722   278.50      3.849   .263   210.48   *
*   1784    93.50 -  94.00    35.50 - 36.00      4.726   .720   289.34      3.838   .272   203.69   *
*   1785    93.50 -  94.00    36.00 - 36.50      4.728   .719   294.28      3.838   .272   196.01   *
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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                             *
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*  GRID     LONG1 - LONG2       LAT1 - LAT2         A(H)    B(H)    R(H)         A(N)   B(N)    R(N)    *
*************************************************************************************************
*                                                                                               *
*  1786     93.50 -  94.00      36.50 - 37.00       4.732   .715    295.41       3.843  .265    190.12  *
*  1787     93.50 -  94.00      37.00 - 37.50       4.737   .712    300.46       3.843  .265    188.58  *
*  1788     93.50 -  94.00      37.50 - 38.00       4.740   .710    308.20       3.847  .259    193.81  *
*  1789     93.50 -  94.00      38.00 - 38.50       4.739   .711    319.73       3.847  .259    205.20  *
*  1790     93.50 -  94.00      38.50 - 39.00       4.739   .711    333.55       3.847  .259    222.13  *
*  1791     93.50 -  94.00      39.00 - 39.50       4.736   .713    348.87       3.836  .268    242.13  *
*  1792     93.50 -  94.00      39.50 - 40.00       4.696   .744    355.99       3.836  .268    265.75  *
*  1793     93.50 -  94.00      40.00 - 40.50       4.676   .758    373.93       3.768  .270    279.84  *
*  1794     93.50 -  94.00      40.50 - 41.00       4.660   .774    397.48       3.730  .285    302.54  *
*  1795     93.50 -  94.00      41.00 - 41.50       3.879   .208    205.80       3.612  .327    318.15  *
*  1796     93.50 -  94.00      41.50 - 42.00       3.840   .172    227.37       3.234  .372    325.99  *
*  1797     93.50 -  94.00      42.00 - 42.50       3.851   .172    240.13       2.621  .255    293.35  *
*  1798     93.50 -  94.00      42.50 - 43.00       3.753   .156    235.47       2.071  .000    241.92  *
*  1799     93.50 -  94.00      43.00 - 43.50       3.699   .161    233.33       2.446  .074    247.43  *
*  1800     93.50 -  94.00      43.50 - 44.00       3.623   .184    234.70       3.236  .414    367.14  *
*  1801     93.50 -  94.00      44.00 - 44.50       3.594   .167    235.17       3.236  .414    350.93  *
*  1802     93.50 -  94.00      44.50 - 45.00       3.525   .184    228.72       3.236  .414    335.02  *
*  1803     93.50 -  94.00      45.00 - 45.50       3.525   .184    217.47       3.236  .414    319.59  *
*  1804     93.50 -  94.00      45.50 - 46.00       3.472   .189    185.40       3.236  .414    305.16  *
*  1805     93.50 -  94.00      46.00 - 46.50       3.419   .213    161.51       3.230  .409    298.47  *
*  1806     93.50 -  94.00      46.50 - 47.00       3.419   .213    183.57       3.230  .409    287.30  *
*  1807     93.50 -  94.00      47.00 - 47.50       3.291   .275    199.13       3.230  .409    280.56  *
*  1808     93.50 -  94.00      47.50 - 48.00       3.271   .305    228.68       3.230  .409    279.01  *
*  1809     93.50 -  94.00      48.00 - 48.50       3.271   .305    255.29       3.074  .553    234.73  *
*  1810     93.50 -  94.00      48.50 - 49.00       3.176   .353    264.01       3.074  .553    242.22  *
*  1811     93.50 -  94.00      49.00 - 49.50       3.176   .353    287.57       3.074  .553    254.21  *
*  1812     93.50 -  94.00      49.50 - 50.00       3.147   .394    308.85       3.074  .553    270.10  *
*  1813     94.00 -  94.50      28.00 - 28.50       2.961   .155    236.60       2.722  .255    146.61  *
*  1814     94.00 -  94.50      28.50 - 29.00       2.961   .155    210.80       2.722  .255    150.95  *
*  1815     94.00 -  94.50      29.00 - 29.50       2.961   .155    186.57       2.722  .255    152.17  *
*  1816     94.00 -  94.50      29.50 - 30.00       3.013   .082    165.66       2.722  .255    142.69  *
*  1817     94.00 -  94.50      30.00 - 30.50       3.245   .111    178.24       2.722  .255    117.74  *
*  1818     94.00 -  94.50      30.50 - 31.00       3.328   .125    163.57       2.839  .206     92.68  *
*  1819     94.00 -  94.50      31.00 - 31.50       3.622   .143    183.04       2.839  .206     65.38  *
*  1820     94.00 -  94.50      31.50 - 32.00       3.751   .158    178.13       3.207  .184    146.00  *
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• SEISMIC MAP OF CONTINENTAL U.S. •

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1821	94.00 - 94.50	32.00 - 32.50	3.798	.141	176.24	3.241	.164	201.38
1822	94.00 - 94.50	32.50 - 33.00	4.613	.806	388.70	3.449	.176	250.88
1823	94.00 - 94.50	33.00 - 33.50	4.623	.798	366.35	3.653	.191	270.68
1824	94.00 - 94.50	33.50 - 34.00	4.623	.798	337.13	3.728	.213	265.69
1825	94.00 - 94.50	34.00 - 34.50	4.646	.780	316.37	3.752	.215	248.95
1826	94.00 - 94.50	34.50 - 35.00	4.660	.771	293.56	3.752	.215	232.52
1827	94.00 - 94.50	35.00 - 35.50	4.673	.760	188.15	3.752	.215	222.31
1828	94.00 - 94.50	35.50 - 36.00	4.579	.757	293.21	3.740	.224	213.96
1829	94.00 - 94.50	36.00 - 36.50	4.680	.755	310.81	3.740	.224	207.31
1830	94.00 - 94.50	36.50 - 37.00	4.731	.716	323.55	3.838	.272	217.72
1831	94.00 - 94.50	37.00 - 37.50	4.735	.713	328.43	3.838	.272	217.10
1832	94.00 - 94.50	37.50 - 38.00	4.737	.712	334.98	3.843	.265	222.39
1833	94.00 - 94.50	38.00 - 38.50	4.736	.713	344.03	3.843	.265	232.49
1834	94.00 - 94.50	38.50 - 39.00	4.736	.713	353.88	3.843	.265	247.51
1835	94.00 - 94.50	39.00 - 39.50	4.733	.716	364.53	3.832	.274	265.79
1836	94.00 - 94.50	39.50 - 40.00	4.692	.747	366.00	3.843	.265	288.63
1837	94.00 - 94.50	40.00 - 40.50	4.672	.762	379.26	3.774	.268	300.30
1838	94.00 - 94.50	40.50 - 41.00	4.655	.778	402.59	3.739	.281	320.70
1839	94.00 - 94.50	41.00 - 41.50	3.872	.206	203.84	3.625	.321	333.88
1840	94.00 - 94.50	41.50 - 42.00	3.828	.173	223.47	3.285	.329	338.26
1841	94.00 - 94.50	42.00 - 42.50	3.840	.172	235.90	2.780	.175	294.23
1842	94.00 - 94.50	42.50 - 43.00	3.739	.155	227.70	2.444	.074	242.05
1843	94.00 - 94.50	43.00 - 43.50	3.654	.136	219.43	2.444	.074	241.15
1844	94.00 - 94.50	43.50 - 44.00	3.540	.154	211.82	3.234	.414	374.01
1845	94.00 - 94.50	44.00 - 44.50	3.475	.144	207.15	3.234	.414	359.47
1846	94.00 - 94.50	44.50 - 45.00	3.350	.151	188.87	3.234	.414	345.89
1847	94.00 - 94.50	45.00 - 45.50	3.350	.151	175.58	3.234	.414	333.16
1848	94.00 - 94.50	45.50 - 46.00	3.218	.203	115.36	3.234	.414	321.52
1849	94.00 - 94.50	46.00 - 46.50	3.135	.148	71.25	3.230	.409	318.16
1850	94.00 - 94.50	46.50 - 47.00	3.135	.148	109.91	3.230	.409	309.29
1851	94.00 - 94.50	47.00 - 47.50	2.972	.189	143.34	3.230	.409	304.20
1852	94.00 - 94.50	47.50 - 48.00	2.923	.238	182.22	3.230	.409	303.58
1853	94.00 - 94.50	48.00 - 48.50	2.923	.238	222.30	3.074	.553	257.68
1854	94.00 - 94.50	48.50 - 49.00	3.147	.394	271.99	3.074	.553	264.52
1855	94.00 - 94.50	49.00 - 49.50	3.147	.394	297.13	3.074	.553	275.54

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1856	94.00 - 94.50	49.50 - 50.00	3.147	.394	322.19	3.074	.553	290.26
1857	94.50 - 95.00	28.00 - 28.50	2.961	.155	241.53	2.722	.255	173.01
1858	94.50 - 95.00	28.50 - 29.00	2.961	.155	214.76	2.722	.255	172.48
1859	94.50 - 95.00	29.00 - 29.50	2.961	.155	188.51	2.722	.255	169.24
1860	94.50 - 95.00	29.50 - 30.00	3.013	.082	164.35	2.722	.255	158.44
1861	94.50 - 95.00	30.00 - 30.50	3.115	.087	146.23	2.722	.255	138.23
1862	94.50 - 95.00	30.50 - 31.00	3.207	.163	127.84	2.839	.206	128.87
1863	94.50 - 95.00	31.00 - 31.50	3.589	.128	147.54	2.839	.206	115.84
1864	94.50 - 95.00	31.50 - 32.00	3.706	.140	125.76	2.922	.187	141.69
1865	94.50 - 95.00	32.00 - 32.50	3.714	.131	133.03	2.898	.225	169.41
1866	94.50 - 95.00	32.50 - 33.00	3.749	.146	156.54	2.987	.184	197.94
1867	94.50 - 95.00	33.00 - 33.50	3.770	.151	156.01	3.394	.172	257.54
1868	94.50 - 95.00	33.50 - 34.00	3.770	.151	134.81	3.524	.209	269.07
1869	94.50 - 95.00	34.00 - 34.50	3.829	.177	119.74	3.524	.209	252.32
1870	94.50 - 95.00	34.50 - 35.00	3.867	.197	134.56	3.524	.209	237.93
1871	94.50 - 95.00	35.00 - 35.50	3.904	.206	134.25	3.524	.209	227.29
1872	94.50 - 95.00	35.50 - 36.00	3.918	.215	159.62	3.504	.224	217.55
1873	94.50 - 95.00	36.00 - 36.50	3.922	.212	178.08	3.504	.224	210.41
1874	94.50 - 95.00	36.50 - 37.00	4.680	.755	339.69	3.740	.224	229.89
1875	94.50 - 95.00	37.00 - 37.50	4.686	.751	345.54	3.740	.224	230.16
1876	94.50 - 95.00	37.50 - 38.00	4.688	.750	350.34	3.740	.224	234.96
1877	94.50 - 95.00	38.00 - 38.50	4.686	.751	354.97	3.740	.224	244.52
1878	94.50 - 95.00	38.50 - 39.00	4.682	.754	356.42	3.740	.224	258.53
1879	94.50 - 95.00	39.00 - 39.50	4.678	.756	357.78	3.727	.234	275.94
1880	94.50 - 95.00	39.50 - 40.00	4.621	.805	342.47	3.740	.224	297.14
1881	94.50 - 95.00	40.00 - 40.50	4.595	.823	335.82	3.644	.225	299.76
1882	94.50 - 95.00	40.50 - 41.00	4.577	.840	369.74	3.601	.232	318.58
1883	94.50 - 95.00	41.00 - 41.50	3.841	.158	200.27	3.457	.261	329.29
1884	94.50 - 95.00	41.50 - 42.00	3.801	.161	210.04	3.091	.285	334.39
1885	94.50 - 95.00	42.00 - 42.50	3.814	.162	221.94	2.722	.255	314.16
1886	94.50 - 95.00	42.50 - 43.00	3.704	.143	208.07	2.294	.225	234.88
1887	94.50 - 95.00	43.00 - 43.50	3.629	.145	201.28	2.444	.074	230.33
1888	94.50 - 95.00	43.50 - 44.00	3.506	.169	192.82	2.444	.074	231.06
1889	94.50 - 95.00	44.00 - 44.50	3.438	.155	190.98	2.444	.074	236.13
1890	94.50 - 95.00	44.50 - 45.00	3.302	.159	173.05	2.446	.074	245.53

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                       * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)         A(N)    C(N)    R(N)

  1891    94.50 -  95.00    45.00 - 45.50     3.302   .159   [illegible]0.30    2.446   .074   258.93
  1892    94.50 -  95.00    45.50 - 46.00     3.163   .189     94.18      2.446   .074   275.79
  1893    94.50 -  95.00    46.00 - 46.50     3.117   .164     28.77      2.296   .225   283.13
  1894    94.50 -  95.00    46.50 - 47.00     3.117   .164     93.06      2.296   .225   305.38
  1895    94.50 -  95.00    47.00 - 47.50     2.923   .238    130.61      2.296   .225   329.74
  1896    94.50 -  95.00    47.50 - 48.00     2.861   .300    170.24      2.296   .225   355.79
  1897    94.50 -  95.00    48.00 - 48.50     2.861   .300    213.31       .000   .000      .00
  1898    94.50 -  95.00    48.50 - 49.00     2.534   .149    190.57      3.074   .553   286.96
  1899    94.50 -  95.00    49.00 - 49.50     2.534   .149    222.65      3.074   .553   297.15
  1900    94.50 -  95.00    49.50 - 50.00     2.534   .149    253.88      3.074   .553   310.85
  1901    95.00 -  95.50    27.00 - 27.50     2.534   .149    315.90      2.722   .255   212.30
  1902    95.00 -  95.50    27.50 - 28.00     2.925   .205    280.64      2.722   .255   203.50
  1903    95.00 -  95.50    28.00 - 28.50     2.961   .155    246.63      2.722   .255   198.44
  1904    95.00 -  95.50    28.50 - 29.00     2.961   .155    218.70      2.722   .255   194.75
  1905    95.00 -  95.50    29.00 - 29.50     2.961   .155    190.50      2.722   .255   189.19
  1906    95.00 -  95.50    29.50 - 30.00     3.013   .082    163.73      2.722   .255   179.08
  1907    95.00 -  95.50    30.00 - 30.50     3.115   .087    142.47      2.722   .255   164.35
  1908    95.00 -  95.50    30.50 - 31.00     3.207   .163    119.54      2.839   .206   165.55
  1909    95.00 -  95.50    31.00 - 31.50     3.448   .140    105.54      2.839   .206   158.73
  1910    95.00 -  95.50    31.50 - 32.00     3.530   .146     44.26      2.839   .206   166.71
  1911    95.00 -  95.50    32.00 - 32.50     3.545   .129     62.67      2.773   .225   175.69
  1912    95.00 -  95.50    32.50 - 33.00     3.545   .129    118.00      2.773   .225   189.88
  1913    95.00 -  95.50    33.00 - 33.50     3.589   .143    125.00      3.315   .170   272.65
  1914    95.00 -  95.50    33.50 - 34.00     3.589   .143     95.55      3.447   .242   288.33
  1915    95.00 -  95.50    34.00 - 34.50     3.641   .138     45.84      3.447   .242   274.05
  1916    95.00 -  95.50    34.50 - 35.00     3.623   .133    103.64      3.447   .242   260.97
  1917    95.00 -  95.50    35.00 - 35.50     3.688   .115    134.03      3.447   .242   250.33
  1918    95.00 -  95.50    35.50 - 36.00     3.729   .125    155.85      3.421   .261   239.85
  1919    95.00 -  95.50    36.00 - 36.50     3.703   .094    165.49      3.421   .261   232.45
  1920    95.00 -  95.50    36.50 - 37.00     3.924   .211    189.35      3.504   .224   232.15
  1921    95.00 -  95.50    37.00 - 37.50     3.939   .219    194.74      3.504   .224   231.85
  1922    95.00 -  95.50    37.50 - 38.00     3.944   .221    194.17      3.504   .224   235.76
  1923    95.00 -  95.50    38.00 - 38.50     3.940   .224    187.88      3.504   .224   244.09
  1924    95.00 -  95.50    38.50 - 39.00     3.940   .224    172.73      3.504   .224   256.67
  1925    95.00 -  95.50    39.00 - 39.50     3.931   .217    152.55      3.482   .241   272.00
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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                                *
****************************************************************************************************
*  GFID     LONG1 - LONG2       LAT1 - LAT2          A(H)     B(H)     R(H)        A(N)    B(N)     R(N)    *
****************************************************************************************************
*                                                                                                  *
*  1526     95.00 -  95.50     39.50 - 40.00        3.937    .151    159.15       3.504   .224    291.44   *
*  1527     95.00 -  95.50     40.00 - 40.50        3.868    .149     98.08       3.482   .241    308.62   *
*  1528     95.00 -  95.50     40.50 - 41.00        3.860    .160    164.39       3.457   .261    327.11   *
*  1529     95.00 -  95.50     41.00 - 41.50        3.822    .149    184.65       3.405   .267    341.03   *
*  1530     95.00 -  95.50     41.50 - 42.00        3.793    .154    196.52       2.940   .316    319.80   *
*  1531     95.00 -  95.50     42.00 - 42.50        3.801    .161    206.00       2.296   .225    224.86   *
*  1532     95.00 -  95.50     42.50 - 43.00        3.704    .143    189.06       2.296   .225    211.21   *
*  1533     95.00 -  95.50     43.00 - 43.50        3.585    .124    169.72       2.296   .225    202.58   *
*  1534     95.00 -  95.50     43.50 - 44.00        3.448    .140    162.11       2.296   .225    199.62   *
*  1535     95.00 -  95.50     44.00 - 44.50        3.362    .137    162.35       2.296   .225    202.58   *
*  1536     95.00 -  95.50     44.50 - 45.00        3.179    .177    140.51       2.296   .225    211.21   *
*  1537     95.00 -  95.50     45.00 - 45.50        3.179    .177    135.06       2.296   .225    224.86   *
*  1538     95.00 -  95.50     45.50 - 46.00        3.185    .198    110.96       2.296   .225    242.68   *
*  1539     95.00 -  95.50     46.00 - 46.50        3.107    .178     68.54       2.296   .225    263.83   *
*  1540     95.00 -  95.50     46.50 - 47.00        3.107    .178    106.84       2.296   .225    287.57   *
*  1541     95.00 -  95.50     47.00 - 47.50        2.923    .238    134.53       2.296   .225    313.32   *
*  1542     95.00 -  95.50     47.50 - 48.00        2.861    .300    171.02       2.296   .225    340.63   *
*  1543     95.00 -  95.50     48.00 - 48.50        2.861    .300    212.41        .000   .000       .00   *
*  1544     95.00 -  95.50     48.50 - 49.00        2.384    .300    174.43        .000   .000       .00   *
*  1545     95.00 -  95.50     49.00 - 49.50        2.384    .300    208.61        .000   .000       .00   *
*  1546     95.00 -  95.50     49.50 - 50.00        2.384    .300    242.88        .000   .000       .00   *
*  1547     95.50 -  96.00     27.00 - 27.50        2.534    .149    338.96       2.722   .255    239.62   *
*  1548     95.50 -  96.00     27.50 - 28.00        2.925    .205    288.06       2.722   .255    230.23   *
*  1549     95.50 -  96.00     28.00 - 28.50        2.961    .155    252.68       2.722   .255    223.59   *
*  1550     95.50 -  96.00     28.50 - 29.00        2.961    .155    223.81       2.722   .255    218.03   *
*  1551     95.50 -  96.00     29.00 - 29.50        2.961    .155    194.23       2.722   .255    211.57   *
*  1552     95.50 -  96.00     29.50 - 30.00        3.013    .082    165.84       2.722   .255    202.90   *
*  1553     95.50 -  96.00     30.00 - 30.50        3.115    .087    143.05       2.722   .255    192.65   *
*  1554     95.50 -  96.00     30.50 - 31.00        3.207    .163    118.88       2.839   .206    199.64   *
*  1555     95.50 -  96.00     31.00 - 31.50        3.448    .140    108.91       2.839   .206    195.83   *
*  1556     95.50 -  96.00     31.50 - 32.00        3.530    .146     84.07       2.839   .206    200.97   *
*  1557     95.50 -  96.00     32.00 - 32.50        3.538    .137     99.20       2.597   .225    171.37   *
*  1558     95.50 -  96.00     32.50 - 33.00        3.538    .137    121.66       2.597   .225    181.75   *
*  1559     95.50 -  96.00     33.00 - 33.50        3.565    .139    118.48       3.251   .213    293.60   *
*  1560     95.50 -  96.00     33.50 - 34.00        3.571    .133     65.08       3.392   .285    311.06   *
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                             *
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*   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    B(H)     R(H)        A(N)    B(N)    R(N)  *
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*                                                                                                  *
*   1961    95.50 -  96.00    34.00 - 34.50     3.571   .133     86.64       3.392   .285  298.63  *
*   1962    95.50 -  96.00    34.50 - 35.00     3.545   .129    102.18       3.392   .285  286.89  *
*   1963    95.50 -  96.00    35.00 - 35.50     3.623   .103    125.82       3.392   .285  276.86  *
*   1964    95.50 -  96.00    35.50 - 36.00     3.671   .112    143.56       3.358   .313  265.60  *
*   1965    95.50 -  96.00    36.00 - 36.50     3.639   .082    149.14       3.358   .313  258.18  *
*   1966    95.50 -  96.00    36.50 - 37.00     3.703   .094    169.58       3.421   .261  254.73  *
*   1967    95.50 -  96.00    37.00 - 37.50     3.743   .105    182.73       3.421   .261  254.27  *
*   1968    95.50 -  96.00    37.50 - 38.00     3.758   .106    182.97       3.421   .261  257.74  *
*   1969    95.50 -  96.00    38.00 - 38.50     3.749   .119    167.89       3.421   .261  265.33  *
*   1970    95.50 -  96.00    38.50 - 39.00     3.749   .119    137.09       3.421   .261  276.91  *
*   1971    95.50 -  96.00    39.00 - 39.50     3.723   .111     76.85       3.392   .285  290.34  *
*   1972    95.50 -  96.00    39.50 - 40.00     3.621   .074     94.27       3.421   .261  307.53  *
*   1973    95.50 -  96.00    40.00 - 40.50     3.595   .076     85.31       3.421   .261  324.34  *
*   1974    95.50 -  96.00    40.50 - 41.00     3.583   .093    109.66       3.392   .285  339.45  *
*   1975    95.50 -  96.00    41.00 - 41.50     3.583   .093    131.97       3.392   .285  356.01  *
*   1976    95.50 -  96.00    41.50 - 42.00     3.528   .105    136.66       2.896   .375  318.32  *
*   1977    95.50 -  96.00    42.00 - 42.50     3.547   .111    143.90       2.296   .225  203.09  *
*   1978    95.50 -  96.00    42.50 - 43.00     3.490   .082    128.33       2.296   .225  187.87  *
*   1979    95.50 -  96.00    43.00 - 43.50     3.605   .128    133.75       2.296   .225  178.11  *
*   1980    95.50 -  96.00    43.50 - 44.00     3.475   .144    142.09       2.296   .225  174.74  *
*   1981    95.50 -  96.00    44.00 - 44.50     3.391   .151    150.84       2.296   .225  178.11  *
*   1982    95.50 -  96.00    44.50 - 45.00     3.218   .203    135.53       2.296   .225  187.87  *
*   1983    95.50 -  96.00    45.00 - 45.50     3.218   .203    138.93       2.296   .225  203.09  *
*   1984    95.50 -  96.00    45.50 - 46.00     3.250   .212    142.12       2.296   .225  222.66  *
*   1985    95.50 -  96.00    46.00 - 46.50     3.185   .198    122.62       2.296   .225  245.54  *
*   1986    95.50 -  96.00    46.50 - 47.00     3.185   .198    146.24       2.296   .225  270.89  *
*   1987    95.50 -  96.00    47.00 - 47.50     3.034   .252    165.73       2.296   .225  298.09  *
*   1988    95.50 -  96.00    47.50 - 48.00     2.861   .300    176.83       2.296   .225  326.66  *
*   1989    95.50 -  96.00    48.00 - 48.50     2.861   .300    215.09        .000   .000     .00  *
*   1990    95.50 -  96.00    48.50 - 49.00     2.384   .300    179.26        .000   .000     .00  *
*   1991    95.50 -  96.00    49.00 - 49.50     2.384   .300    212.66        .000   .000     .00  *
*   1992    95.50 -  96.00    49.50 - 50.00     2.384   .300    246.37        .000   .000     .00  *
*   1993    96.00 -  96.50    25.00 - 25.50      .000   .000       .00       2.822   .367  271.80  *
*   1994    96.00 -  96.50    25.50 - 26.00      .000   .000       .00       2.822   .367  282.10  *
*   1995    96.00 -  96.50    26.00 - 26.50      .000   .000       .00       2.521   .367  265.47  *
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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                          *
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*   GRID     LONG1 - LONG2     LAT1 - LAT2      A(H)   B(H)    R(H)      A(N)   B(N)    R(N)    *
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*
*   1996     96.00 - 96.50     26.50 - 27.00     .000   .000     .00     2.524   .367   254.01  *
*   1997     96.00 - 96.50     27.00 - 27.50     .000   .000     .00     2.722   .255   266.34  *
*   1998     96.00 - 96.50     27.50 - 28.00    2.735   .328   287.55    2.722   .255   256.51  *
*   1999     96.00 - 96.50     28.00 - 28.50    2.806   .230   251.16    2.722   .255   248.89  *
*   2000     96.00 - 96.50     28.50 - 29.00    2.806   .230   217.20    2.722   .255   242.38  *
*   2001     96.00 - 96.50     29.00 - 29.50    2.806   .230   183.41    2.722   .255   235.83  *
*   2002     96.00 - 96.50     29.50 - 30.00    2.890   .122   157.69    2.722   .255   228.68  *
*   2003     96.00 - 96.50     30.00 - 30.50    3.034   .054   140.18    2.722   .255   221.72  *
*   2004     96.00 - 96.50     30.50 - 31.00    3.151   .137   119.15    2.839   .206   231.40  *
*   2005     96.00 - 96.50     31.00 - 31.50    3.407   .154   106.86    2.839   .206   229.16  *
*   2006     96.00 - 96.50     31.50 - 32.00    3.500   .150    46.57    2.839   .206   232.79  *
*   2007     96.00 - 96.50     32.00 - 32.50    3.508   .139   106.91    2.597   .225   198.30  *
*   2008     96.00 - 96.50     32.50 - 33.00    3.508   .139   127.90    2.597   .225   205.46  *
*   2009     96.00 - 96.50     33.00 - 33.50    3.538   .137   125.68    2.597   .225   212.40  *
*   2010     96.00 - 96.50     33.50 - 34.00    3.545   .129   107.93    2.597   .225   218.32  *
*   2011     96.00 - 96.50     34.00 - 34.50    3.545   .129   106.44    2.597   .225   224.10  *
*   2012     96.00 - 96.50     34.50 - 35.00    3.545   .129   105.69    2.597   .225   231.49  *
*   2013     96.00 - 96.50     35.00 - 35.50    3.623   .103   115.02    2.597   .225   242.10  *
*   2014     96.00 - 96.50     35.50 - 36.00    3.671   .112   128.66    2.294   .225   210.32  *
*   2015     96.00 - 96.50     36.00 - 36.50    3.634   .089   135.49    2.294   .225   224.02  *
*   2016     96.00 - 96.50     36.50 - 37.00    3.709   .111   160.59    3.372   .293   278.10  *
*   2017     96.00 - 96.50     37.00 - 37.50    3.749   .119   176.68    3.372   .293   277.97  *
*   2018     96.00 - 96.50     37.50 - 38.00    3.749   .119   175.78    3.372   .293   281.43  *
*   2019     96.00 - 96.50     38.00 - 38.50    3.739   .132   158.13    3.372   .293   288.60  *
*   2020     96.00 - 96.50     38.50 - 39.00    3.739   .132   120.42    3.372   .293   299.41  *
*   2021     96.00 - 96.50     39.00 - 39.50    3.729   .125    83.39    3.333   .327   309.17  *
*   2022     96.00 - 96.50     39.50 - 40.00    3.556   .083    68.63    3.372   .293   325.05  *
*   2023     96.00 - 96.50     40.00 - 40.50    3.504   .063    42.41    3.358   .313   339.90  *
*   2024     96.00 - 96.50     40.50 - 41.00    3.497   .072    87.66    3.358   .313   353.49  *
*   2025     96.00 - 96.50     41.00 - 41.50    3.497   .072   103.09    3.358   .313   365.78  *
*   2026     96.00 - 96.50     41.50 - 42.00    3.463   .075   110.42    2.894   .375   313.53  *
*   2027     96.00 - 96.50     42.00 - 42.50    3.483   .092   115.88    2.294   .225   182.13  *
*   2028     96.00 - 96.50     42.50 - 43.00    3.483   .092   105.71    2.294   .225   164.99  *
*   2029     96.00 - 96.50     43.00 - 43.50    3.515   .092    65.14    2.894   .375   231.61  *
*   2030     96.00 - 96.50     43.50 - 44.00    3.410   .132   112.60    2.894   .375   231.33  *
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*                                 * SEISMIC MAP OF CONTINENTAL U.S. *                               *
*****************************************************************************************************
*   GRID     LONG1 - LONG2     LAT1 - LAT2        A(H)   C(H)    R(H)        A(N)   C(N)    R(N)    *
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*                                                                                                   *
*   2031     96.00 - 96.50     44.00 - 44.50      3.285  .214   117.27       2.894  .375   238.46   *
*   2032     96.00 - 96.50     44.50 - 45.00      3.231  .196   126.17       2.894  .375   252.58   *
*   2033     96.00 - 96.50     45.00 - 45.50      3.231  .196   137.15       2.894  .375   272.18   *
*   2034     96.00 - 96.50     45.50 - 46.00      3.273  .189   159.25       2.894  .375   295.61   *
*   2035     96.00 - 96.50     46.00 - 46.50      3.210  .172   154.00       2.894  .375   321.61   *
*   2036     96.00 - 96.50     46.50 - 47.00      3.210  .172   173.48       2.894  .375   349.33   *
*   2037     96.00 - 96.50     47.00 - 47.50      3.074  .212   186.85       2.294  .225   284.22   *
*   2038     96.00 - 96.50     47.50 - 48.00      2.923  .238   196.76       2.294  .225   314.06   *
*   2039     96.00 - 96.50     48.00 - 48.50      2.861  .300   220.37        .000  .000      .00   *
*   2040     96.00 - 96.50     48.50 - 49.00      2.384  .300   187.03        .000  .000      .00   *
*   2041     96.00 - 96.50     49.00 - 49.50      2.384  .300   219.25        .000  .000      .00   *
*   2042     96.00 - 96.50     49.50 - 50.00      2.384  .300   252.08        .000  .000      .00   *
*   2043     96.50 - 97.00     25.00 - 25.50       .000  .000      .00       2.521  .367   260.12   *
*   2044     96.50 - 97.00     25.50 - 26.00       .000  .000      .00       2.521  .367   292.43   *
*   2045     96.50 - 97.00     26.00 - 26.50       .000  .000      .00       2.521  .367   293.80   *
*   2046     96.50 - 97.00     26.50 - 27.00       .000  .000      .00       2.521  .367   283.50   *
*   2047     96.50 - 97.00     27.00 - 27.50       .000  .000      .00       2.722  .255   292.80   *
*   2048     96.50 - 97.00     27.50 - 28.00      2.735  .328   292.30       2.722  .255   282.72   *
*   2049     96.50 - 97.00     28.00 - 28.50      2.806  .230   256.68       2.722  .255   274.60   *
*   2050     96.50 - 97.00     28.50 - 29.00      2.806  .230   223.46       2.722  .255   267.72   *
*   2051     96.50 - 97.00     29.00 - 29.50      2.806  .230   190.62       2.722  .255   261.46   *
*   2052     96.50 - 97.00     29.50 - 30.00      2.890  .122   166.11       2.722  .255   255.67   *
*   2053     96.50 - 97.00     30.00 - 30.50      3.034  .054   150.51       2.722  .255   251.04   *
*   2054     96.50 - 97.00     30.50 - 31.00      3.151  .137   132.71       2.839  .206   261.53   *
*   2055     96.50 - 97.00     31.00 - 31.50      3.496  .182   146.53       2.839  .206   260.14   *
*   2056     96.50 - 97.00     31.50 - 32.00      3.596  .169   124.61       2.881  .147   263.41   *
*   2057     96.50 - 97.00     32.00 - 32.50      3.596  .169   142.97       2.689  .137   234.83   *
*   2058     96.50 - 97.00     32.50 - 33.00      3.596  .169   154.02       2.689  .137   236.94   *
*   2059     96.50 - 97.00     33.00 - 33.50      3.622  .162   150.73       2.689  .137   239.41   *
*   2060     96.50 - 97.00     33.50 - 34.00      3.628  .154   137.42       2.689  .137   241.76   *
*   2061     96.50 - 97.00     34.00 - 34.50      3.628  .154   123.33       2.689  .137   244.46   *
*   2062     96.50 - 97.00     34.50 - 35.00      3.628  .154   105.05       2.689  .137   248.52   *
*   2063     96.50 - 97.00     35.00 - 35.50      3.694  .132    95.53       2.689  .137   254.93   *
*   2064     96.50 - 97.00     35.50 - 36.00      3.734  .139   111.09       2.444  .074   224.38   *
*   2065     96.50 - 97.00     36.00 - 36.50      3.704  .118   126.43       2.444  .074   232.50   *
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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                              *
*****************************************************************************************************
*   GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)    C(H)    R(H)        A(N)    C(N)    R(N)   *
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*                                                                                                   *
*   2C66    96.50 -  97.00     36.50 - 37.00     3.704   .118   146.84       2.446   .074   244.28  *
*   2C67    96.50 -  97.00     37.00 - 37.50     3.744   .125   166.88       2.446   .074   259.26  *
*   2C68    96.50 -  97.00     37.50 - 38.00     3.744   .125   168.96       2.446   .074   277.01  *
*   2C69    96.50 -  97.00     38.00 - 38.50     3.734   .139   152.70       2.446   .074   297.06  *
*   2C70    96.50 -  97.00     38.50 - 39.00     3.734   .139   109.18       2.940   .316   362.78  *
*   2C71    96.50 -  97.00     39.00 - 39.50     3.724   .132    40.20       2.824   .411   345.75  *
*   2C72    96.50 -  97.00     39.50 - 40.00     3.556   .083    40.24       2.940   .316   326.13  *
*   2C73    96.50 -  97.00     40.00 - 40.50     3.504   .063    70.28       2.894   .375   304.50  *
*   2C74    96.50 -  97.00     40.50 - 41.00     3.497   .072    84.20       2.894   .375   281.63  *
*   2C75    96.50 -  97.00     41.00 - 41.50     3.497   .072    75.96       2.894   .375   260.70  *
*   2C76    96.50 -  97.00     41.50 - 42.00     3.463   .075    93.32       2.894   .375   241.85  *
*   2C77    96.50 -  97.00     42.00 - 42.50     3.483   .092    98.33       2.894   .375   225.33  *
*   2C78    96.50 -  97.00     42.50 - 43.00     3.483   .092    81.05       2.894   .375   211.82  *
*   2C79    96.50 -  97.00     43.00 - 43.50     3.490   .082    91.73       2.984   .309   210.83  *
*   2C80    96.50 -  97.00     43.50 - 44.00     3.382   .115   102.73       2.984   .309   209.46  *
*   2C81    96.50 -  97.00     44.00 - 44.50     3.254   .189   100.71       2.984   .309   216.84  *
*   2C82    96.50 -  97.00     44.50 - 45.00     3.194   .169   109.17       2.984   .309   232.07  *
*   2C83    96.50 -  97.00     45.00 - 45.50     3.194   .169   126.40       2.984   .309   252.74  *
*   2C84    96.50 -  97.00     45.50 - 46.00     3.210   .172   152.59       2.984   .309   276.70  *
*   2C85    96.50 -  97.00     46.00 - 46.50     3.210   .172   168.27       2.984   .309   302.68  *
*   2C86    96.50 -  97.00     46.50 - 47.00     3.210   .172   188.96       2.984   .309   330.02  *
*   2C87    96.50 -  97.00     47.00 - 47.50     3.074   .212   199.54       2.597   .225   309.95  *
*   2C88    96.50 -  97.00     47.50 - 48.00     2.923   .238   206.07       2.597   .225   339.20  *
*   2C89    96.50 -  97.00     48.00 - 48.50     2.861   .300   227.26        .000   .000      .00  *
*   2C90    96.50 -  97.00     48.50 - 49.00     2.384   .300   197.39        .000   .000      .00  *
*   2C91    96.50 -  97.00     49.00 - 49.50     2.384   .300   228.16        .000   .000      .00  *
*   2C92    96.50 -  97.00     49.50 - 50.00     2.384   .300   259.86        .000   .000      .00  *
*   2C93    97.00 -  97.50     25.00 - 25.50      .000   .000      .00       2.521   .367   273.59  *
*   2C94    97.00 -  97.50     25.50 - 26.00      .000   .000      .00       2.521   .367   304.48  *
*   2C95    97.00 -  97.50     26.00 - 26.50      .000   .000      .00        .000   .000      .00  *
*   2C96    97.00 -  97.50     26.50 - 27.00      .000   .000      .00        .000   .000      .00  *
*   2C97    97.00 -  97.50     27.00 - 27.50      .000   .000      .00       2.294   .225   344.82  *
*   2C98    97.00 -  97.50     27.50 - 28.00     2.735   .328   299.94       2.294   .225   317.88  *
*   2C99    97.00 -  97.50     28.00 - 28.50     2.806   .230   265.26       2.294   .225   292.53  *
*   2100    97.00 -  97.50     28.50 - 29.00     2.806   .230   233.17       2.294   .225   269.23  *
*                                                                                                   *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
2101	97.00 - 97.50	29.00 - 29.50	2.806	.230	201.95	2.296	.225	248.54
2102	97.00 - 97.50	29.50 - 30.00	2.854	.167	174.63	2.296	.225	231.17
2103	97.00 - 97.50	30.00 - 30.50	3.013	.082	164.13	2.296	.225	217.91
2104	97.00 - 97.50	30.50 - 31.00	3.081	.115	143.74	2.597	.225	263.12
2105	97.00 - 97.50	31.00 - 31.50	3.455	.203	177.06	2.597	.225	255.45
2106	97.00 - 97.50	31.50 - 32.00	3.568	.178	170.98	2.685	.137	259.31
2107	97.00 - 97.50	32.00 - 32.50	3.568	.178	167.45	2.685	.137	256.87
2108	97.00 - 97.50	32.50 - 33.00	3.568	.178	164.53	2.685	.137	256.12
2109	97.00 - 97.50	33.00 - 33.50	3.588	.179	155.86	2.685	.137	256.05
2110	97.00 - 97.50	33.50 - 34.00	3.596	.169	139.54	2.685	.137	256.30
2111	97.00 - 97.50	34.00 - 34.50	3.596	.169	117.21	2.685	.137	257.16
2112	97.00 - 97.50	34.50 - 35.00	3.596	.169	85.70	2.685	.137	259.35
2113	97.00 - 97.50	35.00 - 35.50	3.666	.146	46.96	2.685	.137	263.76
2114	97.00 - 97.50	35.50 - 36.00	3.708	.154	75.44	2.446	.074	228.86
2115	97.00 - 97.50	36.00 - 36.50	3.678	.130	101.52	2.446	.074	235.36
2116	97.00 - 97.50	36.50 - 37.00	3.699	.125	133.42	2.534	.014	232.01
2117	97.00 - 97.50	37.00 - 37.50	3.739	.132	157.28	2.534	.014	240.25
2118	97.00 - 97.50	37.50 - 38.00	3.739	.132	163.82	2.534	.014	250.91
2119	97.00 - 97.50	38.00 - 38.50	3.729	.147	154.24	2.534	.014	263.79
2120	97.00 - 97.50	38.50 - 39.00	3.729	.147	123.33	2.972	.280	330.47
2121	97.00 - 97.50	39.00 - 39.50	3.719	.139	88.66	2.869	.367	309.09
2122	97.00 - 97.50	39.50 - 40.00	3.550	.089	75.07	3.040	.237	302.11
2123	97.00 - 97.50	40.00 - 40.50	3.497	.072	86.70	3.016	.266	287.73
2124	97.00 - 97.50	40.50 - 41.00	3.497	.072	83.24	3.016	.266	267.65
2125	97.00 - 97.50	41.00 - 41.50	3.497	.072	35.16	3.016	.266	248.40
2126	97.00 - 97.50	41.50 - 42.00	3.463	.075	83.33	3.016	.266	230.27
2127	97.00 - 97.50	42.00 - 42.50	3.483	.092	85.88	2.984	.309	209.07
2128	97.00 - 97.50	42.50 - 43.00	3.483	.092	40.84	2.984	.309	193.41
2129	97.00 - 97.50	43.00 - 43.50	3.483	.092	86.99	2.984	.309	181.97
2130	97.00 - 97.50	43.50 - 44.00	3.372	.125	93.09	2.984	.309	179.02
2131	97.00 - 97.50	44.00 - 44.50	3.243	.192	81.50	2.984	.309	187.80
2132	97.00 - 97.50	44.50 - 45.00	3.194	.169	93.16	2.984	.309	206.37
2133	97.00 - 97.50	45.00 - 45.50	3.194	.169	118.14	2.984	.309	230.43
2134	97.00 - 97.50	45.50 - 46.00	3.210	.172	152.05	2.984	.309	257.10
2135	97.00 - 97.50	46.00 - 46.50	3.210	.172	174.90	2.984	.309	285.13

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
2136	97.00 - 97.50	46.50 - 47.00	3.210	.172	198.51	2.984	.309	314.07
2137	97.00 - 97.50	47.00 - 47.50	3.074	.212	209.58	2.597	.225	296.60
2138	97.00 - 97.50	47.50 - 48.00	2.923	.238	215.14	2.597	.225	326.90
2139	97.00 - 97.50	48.00 - 48.50	2.861	.300	235.03	.000	.000	.00
2140	97.00 - 97.50	48.50 - 49.00	2.384	.300	209.96	.000	.000	.00
2141	97.00 - 97.50	49.00 - 49.50	2.384	.300	239.12	.000	.000	.00
2142	97.00 - 97.50	49.50 - 50.00	2.384	.300	269.54	.000	.000	.00
2143	97.50 - 98.00	25.00 - 25.50	.000	.000	.00	2.521	.367	289.99
2144	97.50 - 98.00	25.50 - 26.00	.000	.000	.00	2.521	.367	319.29
2145	97.50 - 98.00	26.00 - 26.50	.000	.000	.00	.000	.000	.00
2146	97.50 - 98.00	26.50 - 27.00	.000	.000	.00	.000	.000	.00
2147	97.50 - 98.00	27.00 - 27.50	.000	.000	.00	2.294	.225	363.25
2148	97.50 - 98.00	27.50 - 28.00	2.735	.328	310.27	2.294	.225	337.78
2149	97.50 - 98.00	28.00 - 28.50	2.806	.230	276.66	2.294	.225	314.04
2150	97.50 - 98.00	28.50 - 29.00	2.806	.230	245.97	2.294	.225	292.46
2151	97.50 - 98.00	29.00 - 29.50	2.806	.230	216.31	2.294	.225	273.53
2152	97.50 - 98.00	29.50 - 30.00	2.854	.167	190.84	2.294	.225	257.85
2153	97.50 - 98.00	30.00 - 30.50	3.013	.082	183.11	2.294	.225	246.04
2154	97.50 - 98.00	30.50 - 31.00	3.081	.115	166.09	2.294	.225	238.67
2155	97.50 - 98.00	31.00 - 31.50	3.455	.203	207.35	2.294	.225	236.17
2156	97.50 - 98.00	31.50 - 32.00	3.568	.178	200.24	2.444	.074	246.32
2157	97.50 - 98.00	32.00 - 32.50	3.568	.178	188.04	2.444	.074	246.05
2158	97.50 - 98.00	32.50 - 33.00	3.568	.178	176.24	2.444	.074	247.24
2159	97.50 - 98.00	33.00 - 33.50	3.588	.179	162.13	2.444	.074	248.65
2160	97.50 - 98.00	33.50 - 34.00	3.596	.169	141.28	2.534	.014	248.99
2161	97.50 - 98.00	34.00 - 34.50	3.596	.169	113.93	2.534	.014	245.61
2162	97.50 - 98.00	34.50 - 35.00	3.596	.169	78.49	2.534	.014	241.94
2163	97.50 - 98.00	35.00 - 35.50	3.666	.146	38.16	2.534	.014	239.16
2164	97.50 - 98.00	35.50 - 36.00	3.708	.154	36.94	2.372	.000	229.29
2165	97.50 - 98.00	36.00 - 36.50	3.678	.130	85.81	2.372	.000	226.72
2166	97.50 - 98.00	36.50 - 37.00	3.688	.140	121.94	2.534	.014	223.19
2167	97.50 - 98.00	37.00 - 37.50	3.729	.147	144.67	2.534	.014	230.65
2168	97.50 - 98.00	37.50 - 38.00	3.729	.147	156.71	2.534	.014	240.75
2169	97.50 - 98.00	38.00 - 38.50	3.724	.154	158.72	2.534	.014	253.33
2170	97.50 - 98.00	38.50 - 39.00	3.724	.154	145.12	2.972	.280	317.03

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*                           * SEISMIC MAP OF CONTINENTAL U.S. *                          *
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*  GFID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)      A(N)   B(N)    R(N)   *
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*                                                                                        *
*  2171    97.50 -  98.00    39.00 - 39.50     3.729   .147   131.18     2.869  .367   291.16  *
*  2172    97.50 -  98.00    39.50 - 40.00     3.565   .109   107.13     3.040  .237   286.33  *
*  2173    97.50 -  98.00    40.00 - 40.50     3.515   .092   106.80     3.016  .266   270.85  *
*  2174    97.50 -  98.00    40.50 - 41.00     3.490   .082    96.31     3.016  .266   249.83  *
*  2175    97.50 -  98.00    41.00 - 41.50     3.490   .082    77.54     3.016  .266   229.44  *
*  2176    97.50 -  98.00    41.50 - 42.00     3.463   .075    92.67     3.016  .266   209.98  *
*  2177    97.50 -  98.00    42.00 - 42.50     3.483   .092    87.31     2.984  .309   186.89  *
*  2178    97.50 -  98.00    42.50 - 43.00     3.483   .092    41.01     2.984  .309   168.23  *
*  2179    97.50 -  98.00    43.00 - 43.50     3.515   .092    90.06     3.016  .266   154.90  *
*  2180    97.50 -  98.00    43.50 - 44.00     3.410   .132    84.48     3.016  .266   148.91  *
*  2181    97.50 -  98.00    44.00 - 44.50     3.285   .214    55.34     3.016  .266   159.87  *
*  2182    97.50 -  98.00    44.50 - 45.00     3.243   .192    79.16     3.016  .266   182.71  *
*  2183    97.50 -  98.00    45.00 - 45.50     3.243   .192   115.40     3.016  .266   209.59  *
*  2184    97.50 -  98.00    45.50 - 46.00     3.294   .168   163.49     3.016  .266   237.37  *
*  2185    97.50 -  98.00    46.00 - 46.50     3.294   .168   192.49     3.016  .266   265.49  *
*  2186    97.50 -  98.00    46.50 - 47.00     3.294   .168   219.74     3.016  .266   294.00  *
*  2187    97.50 -  98.00    47.00 - 47.50     3.107   .178   221.90     2.689  .137   285.01  *
*  2188    97.50 -  98.00    47.50 - 48.00     2.972   .189   231.47     2.689  .137   313.74  *
*  2189    97.50 -  98.00    48.00 - 48.50     2.861   .300   243.33     2.071  .000   387.52  *
*  2190    97.50 -  98.00    48.50 - 49.00     2.384   .300   224.38      .000  .000      .00  *
*  2191    97.50 -  98.00    49.00 - 49.50     2.384   .300   251.87      .000  .000      .00  *
*  2192    97.50 -  98.00    49.50 - 50.00     2.384   .300   280.91      .000  .000      .00  *
*  2193    98.00 -  98.50    25.00 - 25.50      .000   .000      .00     2.521  .367   308.85  *
*  2194    98.00 -  98.50    25.50 - 26.00      .000   .000      .00     2.521  .367   336.51  *
*  2195    98.00 -  98.50    26.00 - 26.50      .000   .000      .00     2.296  .225   284.71  *
*  2196    98.00 -  98.50    26.50 - 27.00      .000   .000      .00     2.296  .225   278.37  *
*  2197    98.00 -  98.50    27.00 - 27.50      .000   .000      .00     2.597  .225   318.61  *
*  2198    98.00 -  98.50    27.50 - 28.00     2.735   .328   323.08     2.597  .225   312.16  *
*  2199    98.00 -  98.50    28.00 - 28.50     2.806   .230   290.98     2.597  .225   307.93  *
*  2200    98.00 -  98.50    28.50 - 29.00     2.806   .230   261.48     2.597  .225   305.34  *
*  2201    98.00 -  98.50    29.00 - 29.50     2.806   .230   233.74     2.597  .225   303.95  *
*  2202    98.00 -  98.50    29.50 - 30.00     2.854   .167   209.80     2.597  .225   303.64  *
*  2203    98.00 -  98.50    30.00 - 30.50     2.989   .115   202.55     2.597  .225   304.64  *
*  2204    98.00 -  98.50    30.50 - 31.00     3.061   .137   187.34     2.597  .225   307.54  *
*  2205    98.00 -  98.50    31.00 - 31.50     3.443   .220   230.73     2.597  .225   312.97  *
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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                            *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)   C(N)    R(N)  *
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*                                                                                             *
*  2206   98.00 -  98.50   31.50 - 32.00      3.559   .190   219.69      2.446   .074   264.14  *
*  2207   98.00 -  98.50   32.00 - 32.50      3.580   .190   205.78      2.446   .074   260.38  *
*  2208   98.00 -  98.50   32.50 - 33.00      3.580   .190   188.45      2.446   .074   257.06  *
*  2209   98.00 -  98.50   33.00 - 33.50      3.600   .191   169.80      2.446   .074   253.14  *
*  2210   98.00 -  98.50   33.50 - 34.00      3.607   .181   144.60      2.534   .014   245.54  *
*  2211   98.00 -  98.50   34.00 - 34.50      3.607   .181   112.23      2.534   .014   236.88  *
*  2212   98.00 -  98.50   34.50 - 35.00      3.607   .181    80.66      2.534   .014   228.36  *
*  2213   98.00 -  98.50   35.00 - 35.50      3.677   .156    69.46      2.534   .014   221.69  *
*  2214   98.00 -  98.50   35.50 - 36.00      3.718   .162    43.57      2.373   .000   201.29  *
*  2215   98.00 -  98.50   36.00 - 36.50      3.688   .140    89.11      2.373   .000   199.23  *
*  2216   98.00 -  98.50   36.50 - 37.00      3.704   .143   117.20      2.548   .000   221.43  *
*  2217   98.00 -  98.50   37.00 - 37.50      3.744   .147   121.58      2.548   .000   228.04  *
*  2218   98.00 -  98.50   37.50 - 38.00      3.744   .147   148.03      2.548   .000   237.92  *
*  2219   98.00 -  98.50   38.00 - 38.50      3.739   .155   164.89      2.548   .000   250.92  *
*  2220   98.00 -  98.50   38.50 - 39.00      3.753   .156   166.25      2.896   .343   273.85  *
*  2221   98.00 -  98.50   39.00 - 39.50      3.758   .149   161.49      2.896   .343   268.17  *
*  2222   98.00 -  98.50   39.50 - 40.00      3.607   .129   134.40      3.060   .216   268.34  *
*  2223   98.00 -  98.50   40.00 - 40.50      3.544   .096   127.29      3.060   .216   252.90  *
*  2224   98.00 -  98.50   40.50 - 41.00      3.522   .083   120.10      3.040   .237   232.43  *
*  2225   98.00 -  98.50   41.00 - 41.50      3.522   .083   114.35      3.040   .237   211.31  *
*  2226   98.00 -  98.50   41.50 - 42.00      3.497   .072   113.34      3.040   .237   191.09  *
*  2227   98.00 -  98.50   42.00 - 42.50      3.515   .092   106.14      3.016   .266   168.82  *
*  2228   98.00 -  98.50   42.50 - 43.00      3.515   .092    86.96      3.016   .266   147.46  *
*  2229   98.00 -  98.50   43.00 - 43.50      3.522   .083   102.33      3.016   .266   124.49  *
*  2230   98.00 -  98.50   43.50 - 44.00      3.419   .125    78.22      3.016   .266   112.06  *
*  2231   98.00 -  98.50   44.00 - 44.50      3.294   .213    23.64      3.016   .266   128.80  *
*  2232   98.00 -  98.50   44.50 - 45.00      3.254   .189    69.64      3.016   .266   159.87  *
*  2233   98.00 -  98.50   45.00 - 45.50      3.254   .189   112.87      3.016   .266   191.42  *
*  2234   98.00 -  98.50   45.50 - 46.00      3.312   .149   165.00      3.016   .266   221.67  *
*  2235   98.00 -  98.50   46.00 - 46.50      3.312   .149   196.35      3.016   .266   251.32  *
*  2236   98.00 -  98.50   46.50 - 47.00      3.312   .149   225.00      3.016   .266   280.96  *
*  2237   98.00 -  98.50   47.00 - 47.50      3.136   .149   230.51      2.689   .137   273.93  *
*  2238   98.00 -  98.50   47.50 - 48.00      3.011   .149   242.58      2.689   .137   303.34  *
*  2239   98.00 -  98.50   48.00 - 48.50      2.923   .238   262.10      2.071   .000   370.60  *
*  2240   98.00 -  98.50   48.50 - 49.00      2.384   .300   240.30       .000   .000      .00  *
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**************************************************************************************************
*                              * SEISMIC MAP OF CONTINENTAL U.S. *                               *
**************************************************************************************************
*  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    B(H)    R(H)        A(N)   B(N)    R(N)  *
**************************************************************************************************
*                                                                                                *
*  2241    98.00 -  98.50    49.00 - 49.50       2.384   .300   266.15        .000   .000     .00  *
*  2242    98.00 -  98.50    49.50 - 50.00       2.384   .300   293.79        .000   .000     .00  *
*  2243    98.50 -  99.00    25.00 - 25.50        .000   .000      .00       2.722   .255  308.60  *
*  2244    98.50 -  99.00    25.50 - 26.00        .000   .000      .00       2.722   .255  313.52  *
*  2245    98.50 -  99.00    26.00 - 26.50        .000   .000      .00       2.296   .225  255.08  *
*  2246    98.50 -  99.00    26.50 - 27.00        .000   .000      .00       2.296   .225  247.98  *
*  2247    98.50 -  99.00    27.00 - 27.50        .000   .000      .00       2.296   .225  245.57  *
*  2248    98.50 -  99.00    27.50 - 28.00       2.735   .328   338.09       2.296   .225  247.98  *
*  2249    98.50 -  99.00    28.00 - 28.50       2.806   .230   306.70       2.296   .225  255.08  *
*  2250    98.50 -  99.00    28.50 - 29.00       2.806   .230   279.26       2.296   .225  266.49  *
*  2251    98.50 -  99.00    29.00 - 29.50       2.806   .230   253.46       2.296   .225  281.69  *
*  2252    98.50 -  99.00    29.50 - 30.00       2.854   .167   230.76       2.296   .225  300.10  *
*  2253    98.50 -  99.00    30.00 - 30.50       2.989   .115   225.17       2.296   .225  321.18  *
*  2254    98.50 -  99.00    30.50 - 31.00       3.061   .137   209.62       2.296   .225  344.42  *
*  2255    98.50 -  99.00    31.00 - 31.50       3.443   .220   250.79       2.296   .225  369.43  *
*  2256    98.50 -  99.00    31.50 - 32.00       3.580   .190   237.50       2.071   .000  309.64  *
*  2257    98.50 -  99.00    32.00 - 32.50       3.600   .191   219.95       2.372   .000  317.50  *
*  2258    98.50 -  99.00    32.50 - 33.00       3.600   .191   199.36       2.372   .000  288.85  *
*  2259    98.50 -  99.00    33.00 - 33.50       3.618   .193   177.61       2.372   .000  261.48  *
*  2260    98.50 -  99.00    33.50 - 34.00       3.625   .183   150.39       2.548   .000  260.06  *
*  2261    98.50 -  99.00    34.00 - 34.50       3.625   .183   112.41       2.548   .000  235.73  *
*  2262    98.50 -  99.00    34.50 - 35.00       3.625   .183    51.15       2.548   .000  215.15  *
*  2263    98.50 -  99.00    35.00 - 35.50       3.693   .158    90.82       2.548   .000  199.99  *
*  2264    98.50 -  99.00    35.50 - 36.00       3.733   .162    91.21       2.548   .000  191.67  *
*  2265    98.50 -  99.00    36.00 - 36.50       3.704   .143   107.37       2.548   .000  190.27  *
*  2266    98.50 -  99.00    36.50 - 37.00       3.698   .150   114.67       2.548   .000  194.35  *
*  2267    98.50 -  99.00    37.00 - 37.50       3.739   .155    63.24       2.548   .000  202.17  *
*  2268    98.50 -  99.00    37.50 - 38.00       3.739   .155   138.34       2.548   .000  212.92  *
*  2269    98.50 -  99.00    38.00 - 38.50       3.733   .162   167.42       2.548   .000  226.74  *
*  2270    98.50 -  99.00    38.50 - 39.00       3.753   .156   177.10       2.896   .343  256.80  *
*  2271    98.50 -  99.00    39.00 - 39.50       3.758   .149   175.83       2.896   .343  252.23  *
*  2272    98.50 -  99.00    39.50 - 40.00       3.607   .129   146.15       3.060   .216  254.69  *
*  2273    98.50 -  99.00    40.00 - 40.50       3.550   .089   140.87       3.060   .216  238.66  *
*  2274    98.50 -  99.00    40.50 - 41.00       3.528   .075   137.81       3.040   .237  217.05  *
*  2275    98.50 -  99.00    41.00 - 41.50       3.528   .075   135.72       3.040   .237  194.76  *
*                                                                                                *
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• SEISMIC MAP OF CONTINENTAL U.S. •

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	D(H)	R(H)	A(N)	D(N)	R(N)
2276	98.50 - 99.00	41.50 - 42.00	3.504	.063	130.55	3.040	.237	173.56
2277	98.50 - 99.00	42.00 - 42.50	3.522	.083	126.35	3.014	.266	150.60
2278	98.50 - 99.00	42.50 - 43.00	3.522	.083	118.54	3.014	.266	127.73
2279	98.50 - 99.00	43.00 - 43.50	3.522	.083	117.94	3.119	.221	107.73
2280	98.50 - 99.00	43.50 - 44.00	3.419	.125	90.19	3.079	.238	72.76
2281	98.50 - 99.00	44.00 - 44.50	3.294	.213	56.46	3.079	.238	106.17
2282	98.50 - 99.00	44.50 - 45.00	3.254	.189	80.39	3.014	.266	141.36
2283	98.50 - 99.00	45.00 - 45.50	3.254	.189	116.95	3.014	.266	176.68
2284	98.50 - 99.00	45.50 - 46.00	3.312	.149	167.97	3.014	.266	208.50
2285	98.50 - 99.00	46.00 - 46.50	3.312	.149	199.44	3.014	.266	239.14
2286	98.50 - 99.00	46.50 - 47.00	3.312	.149	228.63	3.014	.266	269.61
2287	98.50 - 99.00	47.00 - 47.50	3.136	.149	235.19	2.685	.137	264.41
2288	98.50 - 99.00	47.50 - 48.00	3.011	.149	248.48	2.685	.137	294.34
2289	98.50 - 99.00	48.00 - 48.50	2.923	.238	269.96	2.079	.000	354.60
2290	98.50 - 99.00	48.50 - 49.00	2.736	.300	185.22	.000	.000	.00
2291	98.50 - 99.00	49.00 - 49.50	2.736	.300	190.62	.000	.000	.00
2292	98.50 - 99.00	49.50 - 50.00	2.736	.300	198.07	.000	.000	.00
2293	99.00 - 99.50	25.00 - 25.50	.000	.000	.00	2.722	.255	305.54
2294	99.00 - 99.50	25.50 - 26.00	.000	.000	.00	2.722	.255	304.42
2295	99.00 - 99.50	26.00 - 26.50	.000	.000	.00	2.294	.225	225.73
2296	99.00 - 99.50	26.50 - 27.00	.000	.000	.00	2.296	.225	217.68
2297	99.00 - 99.50	27.00 - 27.50	.000	.000	.00	2.296	.225	214.93
2298	99.00 - 99.50	27.50 - 28.00	2.735	.328	355.05	2.296	.225	217.68
2299	99.00 - 99.50	28.00 - 28.50	2.806	.230	324.70	2.296	.225	225.73
2300	99.00 - 99.50	28.50 - 29.00	2.806	.230	298.91	2.294	.225	238.55
2301	99.00 - 99.50	29.00 - 29.50	2.806	.230	274.99	2.296	.225	255.42
2302	99.00 - 99.50	29.50 - 30.00	2.854	.167	253.16	2.294	.225	275.59
2303	99.00 - 99.50	30.00 - 30.50	2.989	.115	248.52	2.294	.225	298.40
2304	99.00 - 99.50	30.50 - 31.00	3.061	.137	231.35	2.296	.225	323.29
2305	99.00 - 99.50	31.00 - 31.50	3.382	.189	254.18	2.294	.225	349.82
2306	99.00 - 99.50	31.50 - 32.00	3.527	.182	237.07	2.079	.000	298.03
2307	99.00 - 99.50	32.00 - 32.50	3.547	.187	217.65	2.372	.000	302.53
2308	99.00 - 99.50	32.50 - 33.00	3.547	.187	196.08	2.379	.000	272.30
2309	99.00 - 99.50	33.00 - 33.50	3.566	.193	174.13	2.379	.000	243.01
2310	99.00 - 99.50	33.50 - 34.00	3.574	.184	148.80	2.548	.000	239.53

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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                              *
*****************************************************************************************************
*   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)        A(N)    C(N)    R(N)   *
*****************************************************************************************************
*                                                                                                   *
*   2311    99.00 -  99.50     34.00 - 34.50      3.574   .184    118.97       2.548   .000   212.29  *
*   2312    99.00 -  99.50     34.50 - 35.00      3.574   .184     93.82       2.548   .000   188.52  *
*   2313    99.00 -  99.50     35.00 - 35.50      3.651   .151    106.95       2.548   .000   170.70  *
*   2314    99.00 -  99.50     35.50 - 36.00      3.698   .150    116.71       2.548   .000   161.55  *
*   2315    99.00 -  99.50     36.00 - 36.50      3.663   .137    119.44       2.548   .000   161.54  *
*   2316    99.00 -  99.50     36.50 - 37.00      3.698   .150    127.85       2.962   .034   200.81  *
*   2317    99.00 -  99.50     37.00 - 37.50      3.739   .155    123.31       2.962   .034   203.50  *
*   2318    99.00 -  99.50     37.50 - 38.00      3.739   .155    148.15       2.962   .034   207.64  *
*   2319    99.00 -  99.50     38.00 - 38.50      3.733   .162    171.57       2.962   .034   213.54  *
*   2320    99.00 -  99.50     38.50 - 39.00      3.753   .156    184.32       3.197   .167   255.75  *
*   2321    99.00 -  99.50     39.00 - 39.50      3.758   .149    179.24       3.197   .167   255.32  *
*   2322    99.00 -  99.50     39.50 - 40.00      3.607   .129    135.77       3.266   .126   249.26  *
*   2323    99.00 -  99.50     40.00 - 40.50      3.550   .089    145.52       3.266   .126   240.14  *
*   2324    99.00 -  99.50     40.50 - 41.00      3.528   .075    150.94       3.254   .144   226.03  *
*   2325    99.00 -  99.50     41.00 - 41.50      3.528   .075    151.02       3.241   .164   207.40  *
*   2326    99.00 -  99.50     41.50 - 42.00      3.504   .063    144.89       3.132   .202   166.05  *
*   2327    99.00 -  99.50     42.00 - 42.50      3.522   .083    142.05       3.115   .221   146.03  *
*   2328    99.00 -  99.50     42.50 - 43.00      3.522   .083    135.84       3.115   .221   125.45  *
*   2329    99.00 -  99.50     43.00 - 43.50      3.522   .083    131.57       3.935   .240   227.40  *
*   2330    99.00 -  99.50     43.50 - 44.00      3.419   .125    109.27       3.927   .245    99.52  *
*   2331    99.00 -  99.50     44.00 - 44.50      3.294   .213     88.50       3.266   .310   115.73  *
*   2332    99.00 -  99.50     44.50 - 45.00      3.292   .219    102.16       3.016   .266   130.30  *
*   2333    99.00 -  99.50     45.00 - 45.50      3.292   .219    126.64       3.016   .266   166.00  *
*   2334    99.00 -  99.50     45.50 - 46.00      3.375   .169    176.04       3.016   .266   197.98  *
*   2335    99.00 -  99.50     46.00 - 46.50      3.375   .169    200.00       3.016   .266   229.00  *
*   2336    99.00 -  99.50     46.50 - 47.00      3.375   .169    220.35       3.016   .266   259.99  *
*   2337    99.00 -  99.50     47.00 - 47.50      3.227   .177    216.86       2.685   .137   256.42  *
*   2338    99.00 -  99.50     47.50 - 48.00      3.128   .184    215.80       2.685   .137   286.75  *
*   2339    99.00 -  99.50     48.00 - 48.50      3.058   .254    216.61       2.071   .000   339.65  *
*   2340    99.00 -  99.50     48.50 - 49.00      3.082   .490    187.54        .000   .000      .00  *
*   2341    99.00 -  99.50     49.00 - 49.50      3.082   .490    186.06        .000   .000      .00  *
*   2342    99.00 -  99.50     49.50 - 50.00      3.082   .490    186.82        .000   .000      .00  *
*   2343    99.50 - 100.00     25.00 - 25.50       .000   .000       .00       2.296   .225   230.24  *
*   2344    99.50 - 100.00     25.50 - 26.00       .000   .000       .00       2.296   .225   211.37  *
*   2345    99.50 - 100.00     26.00 - 26.50       .000   .000       .00       2.597   .225   240.43  *
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                        * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2      LAT1 - LAT2         A(H)    C(H)    R(H)         A(N)    C(N)    R(N)

  2346    99.50 - 100.00     26.50 - 27.00       2.819   .511    217.95       2.597   .225    228.64
  2347    99.50 - 100.00     27.00 - 27.50       2.819   .511    204.34       2.597   .225    222.60
  2348    99.50 - 100.00     27.50 - 28.00       3.126   .364    255.99       2.597   .225    222.41
  2349    99.50 - 100.00     28.00 - 28.50       3.155   .325    243.83       2.597   .225    227.51
  2350    99.50 - 100.00     28.50 - 29.00       3.155   .325    229.52       2.597   .225    236.96
  2351    99.50 - 100.00     29.00 - 29.50       3.155   .325    217.31       2.597   .225    249.91
  2352    99.50 - 100.00     29.50 - 30.00       3.177   .296    209.53       2.597   .225    265.73
  2353    99.50 - 100.00     30.00 - 30.50       3.255   .230    215.04       2.597   .225    284.04
  2354    99.50 - 100.00     30.50 - 31.00       3.299   .205    212.13       2.597   .225    304.56
  2355    99.50 - 100.00     31.00 - 31.50       3.484   .178    226.05       2.597   .225    327.05
  2356    99.50 - 100.00     31.50 - 32.00       3.584   .151    217.02       2.446   .074    295.45
  2357    99.50 - 100.00     32.00 - 32.50       3.598   .154    204.83       2.534   .014    273.68
  2358    99.50 - 100.00     32.50 - 33.00       3.598   .154    190.57       2.597   .076    253.48
  2359    99.50 - 100.00     33.00 - 33.50       3.611   .157    174.06       2.722   .187    251.04
  2360    99.50 - 100.00     33.50 - 34.00       3.617   .150    154.90       2.754   .184    217.38
  2361    99.50 - 100.00     34.00 - 34.50       3.617   .150    134.52       2.754   .184    193.12
  2362    99.50 - 100.00     34.50 - 35.00       3.617   .150    118.94       2.754   .184    170.14
  2363    99.50 - 100.00     35.00 - 35.50       3.651   .151    121.11       2.881   .065    172.61
  2364    99.50 - 100.00     35.50 - 36.00       3.698   .150    129.80       2.881   .065    160.77
  2365    99.50 - 100.00     36.00 - 36.50       3.663   .137    130.39       2.962   .034    172.60
  2366    99.50 - 100.00     36.50 - 37.00       3.664   .136    134.31       3.899   .227    305.94
  2367    99.50 - 100.00     37.00 - 37.50       3.710   .134    141.18       3.899   .227    294.16
  2368    99.50 - 100.00     37.50 - 38.00       3.710   .134    139.30       3.899   .227    283.35
  2369    99.50 - 100.00     38.00 - 38.50       3.705   .141    164.26       3.899   .227    274.53
  2370    99.50 - 100.00     38.50 - 39.00       3.725   .138    181.63       3.944   .235    276.02
  2371    99.50 - 100.00     39.00 - 39.50       3.730   .132    171.07       3.944   .235    270.91
  2372    99.50 - 100.00     39.50 - 40.00       3.613   .124     78.87       3.959   .225    267.69
  2373    99.50 - 100.00     40.00 - 40.50       3.558   .082    146.40       3.959   .225    266.46
  2374    99.50 - 100.00     40.50 - 41.00       3.528   .075    162.14       3.955   .231    265.72
  2375    99.50 - 100.00     41.00 - 41.50       3.528   .075    163.41       3.952   .236    264.82
  2376    99.50 - 100.00     41.50 - 42.00       3.504   .063    156.36       3.939   .234    260.22
  2377    99.50 - 100.00     42.00 - 42.50       3.522   .083    152.50       3.935   .240    254.60
  2378    99.50 - 100.00     42.50 - 43.00       3.522   .083    144.20       3.935   .240    246.84
  2379    99.50 - 100.00     43.00 - 43.50       3.549   .099    139.78       3.987   .236    234.10
  2380    99.50 - 100.00     43.50 - 44.00       3.450   .146    123.69       3.981   .241    202.34
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                        * SEISMIC MAP OF CONTINENTAL U.S. *

 GFID    LONG1 - LONG2     LAT1 - LAT2       A(H)   B(H)    R(H)       A(N)   B(N)    R(N)

 2381   99.50 - 100.00    44.00 - 44.50     3.328   .240   109.40     3.302   .286   128.73
 2382   99.50 - 100.00    44.50 - 45.00     3.292   .219   117.04     3.074   .238   132.48
 2383   99.50 - 100.00    45.00 - 45.50     3.292   .219   135.11     3.074   .238   164.14
 2384   99.50 - 100.00    45.50 - 46.00     3.375   .169   181.23     3.074   .238   193.92
 2385   99.50 - 100.00    46.00 - 46.50     3.324   .398   167.59     3.074   .238   223.29
 2386   99.50 - 100.00    46.50 - 47.00     3.324   .398   177.56     3.074   .238   252.80
 2387   99.50 - 100.00    47.00 - 47.50     3.266   .397   185.46     2.839   .163   270.20
 2388   99.50 - 100.00    47.50 - 48.00     3.228   .403   187.87     2.839   .163   299.99
 2389   99.50 - 100.00    48.00 - 48.50     3.201   .424   187.54     2.446   .074   334.16
 2390   99.50 - 100.00    48.50 - 49.00     3.082   .490   175.10      .000   .000      .00
 2391   99.50 - 100.00    49.00 - 49.50     3.082   .490   172.85      .000   .000      .00
 2392   99.50 - 100.00    49.50 - 50.00     3.082   .490   173.18      .000   .000      .00
 2393  100.00 - 100.50    25.00 - 25.50      .000   .000      .00     2.597   .225   253.19
 2394  100.00 - 100.50    25.50 - 26.00      .000   .000      .00     2.597   .225   229.76
 2395  100.00 - 100.50    26.00 - 26.50     2.181   .000   218.50     2.597   .225   210.52
 2396  100.00 - 100.50    26.50 - 27.00     2.877   .462   196.82     2.597   .225   196.98
 2397  100.00 - 100.50    27.00 - 27.50     2.877   .462   183.40     2.597   .225   190.38
 2398  100.00 - 100.50    27.50 - 28.00     3.028   .337   200.98     2.597   .225   190.93
 2399  100.00 - 100.50    28.00 - 28.50     3.028   .337   187.68     2.597   .225   197.62
 2400  100.00 - 100.50    28.50 - 29.00     3.028   .337   176.03     2.597   .225   208.89
 2401  100.00 - 100.50    29.00 - 29.50     3.028   .337   166.38     2.597   .225   223.52
 2402  100.00 - 100.50    29.50 - 30.00     3.052   .315   161.75     2.597   .225   240.84
 2403  100.00 - 100.50    30.00 - 30.50     3.052   .315   156.83     2.597   .225   260.54
 2404  100.00 - 100.50    30.50 - 31.00     3.127   .274   164.43     2.597   .225   282.42
 2405  100.00 - 100.50    31.00 - 31.50     3.403   .188   203.51     2.597   .225   306.24
 2406  100.00 - 100.50    31.50 - 32.00     3.522   .152   203.15     2.446   .074   280.74
 2407  100.00 - 100.50    32.00 - 32.50     3.546   .145   191.62     2.534   .014   261.26
 2408  100.00 - 100.50    32.50 - 33.00     3.546   .145   179.77     2.597   .076   241.39
 2409  100.00 - 100.50    33.00 - 33.50     3.560   .150   165.61     2.722   .187   237.43
 2410  100.00 - 100.50    33.50 - 34.00     3.566   .144   148.35     2.754   .184   203.24
 2411  100.00 - 100.50    34.00 - 34.50     3.566   .144   129.30     2.754   .184   176.29
 2412  100.00 - 100.50    34.50 - 35.00     3.559   .152   110.97     2.754   .184   148.73
 2413  100.00 - 100.50    35.00 - 35.50     3.578   .154   104.52     2.881   .065   141.95
 2414  100.00 - 100.50    35.50 - 36.00     3.636   .144   114.67     3.839   .237   281.90
 2415  100.00 - 100.50    36.00 - 36.50     3.636   .144   126.38     3.896   .227   288.46
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *
*  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)         A(N)    C(N)    R(N)   *

   2416   100.00 - 100.50    36.50 - 37.00      3.707   .147   140.21        3.946   .235   280.85
   2417   100.00 - 100.50    37.00 - 37.50      3.751   .138   145.77        3.946   .235   269.26
   2418   100.00 - 100.50    37.50 - 38.00      3.751   .138    89.45        3.946   .235   257.72
   2419   100.00 - 100.50    38.00 - 38.50      3.746   .143   161.24        3.946   .235   248.24
   2420   100.00 - 100.50    38.50 - 39.00      3.764   .143   183.71        3.989   .237   249.54
   2421   100.00 - 100.50    39.00 - 39.50      3.752   .131   181.50        3.989   .237   244.25
   2422   100.00 - 100.50    39.50 - 40.00      3.639   .136   144.88        4.001   .229   241.50
   2423   100.00 - 100.50    40.00 - 40.50      3.589   .095   158.68        4.008   .225   242.09
   2424   100.00 - 100.50    40.50 - 41.00      3.563   .086   168.46        4.005   .230   242.77
   2425   100.00 - 100.50    41.00 - 41.50      3.556   .093   169.94        4.002   .234   242.86
   2426   100.00 - 100.50    41.50 - 42.00      3.534   .079   162.29        3.990   .232   238.26
   2427   100.00 - 100.50    42.00 - 42.50      3.528   .086   152.82        3.987   .236   231.27
   2428   100.00 - 100.50    42.50 - 43.00      3.528   .086   139.70        3.987   .236   226.09
   2429   100.00 - 100.50    43.00 - 43.50      3.557   .091   132.22        3.999   .239   228.68
   2430   100.00 - 100.50    43.50 - 44.00      3.459   .140   122.86        3.993   .243   236.94
   2431   100.00 - 100.50    44.00 - 44.50      3.338   .239   115.64        3.377   .268   150.22
   2432   100.00 - 100.50    44.50 - 45.00      3.304   .218   124.76        3.190   .210   147.49
   2433   100.00 - 100.50    45.00 - 45.50      3.304   .218   140.35        3.190   .210   176.39
   2434   100.00 - 100.50    45.50 - 46.00      3.395   .149   185.71        3.190   .210   205.61
   2435   100.00 - 100.50    46.00 - 46.50      3.324   .398   167.82        3.190   .210   235.09
   2436   100.00 - 100.50    46.50 - 47.00      3.324   .398   175.62        3.190   .210   264.88
   2437   100.00 - 100.50    47.00 - 47.50      3.266   .397   180.48        2.954   .145   266.01
   2438   100.00 - 100.50    47.50 - 48.00      3.228   .403   180.04        2.954   .145   293.31
   2439   100.00 - 100.50    48.00 - 48.50      3.201   .424   177.59        2.446   .074   320.38
   2440   100.00 - 100.50    48.50 - 49.00      3.082   .490   161.88         .000   .000      .00
   2441   100.00 - 100.50    49.00 - 49.50      3.082   .490   159.04         .000   .000      .00
   2442   100.00 - 100.50    49.50 - 50.00      3.082   .490   159.07         .000   .000      .00
   2443   100.50 - 101.00    25.00 - 25.50       .000   .000      .00        2.597   .225   230.03
   2444   100.50 - 101.00    25.50 - 26.00       .000   .000      .00        2.597   .225   203.43
   2445   100.50 - 101.00    26.00 - 26.50      2.181   .000   207.07        2.946   .177   246.61
   2446   100.50 - 101.00    26.50 - 27.00      2.877   .462   186.45        2.946   .177   226.41
   2447   100.50 - 101.00    27.00 - 27.50      2.877   .462   172.23        2.946   .177   215.22
   2448   100.50 - 101.00    27.50 - 28.00      3.028   .337   188.78        2.946   .177   213.33
   2449   100.50 - 101.00    28.00 - 28.50      3.028   .337   174.54        2.946   .177   217.87
   2450   100.50 - 101.00    28.50 - 29.00      3.028   .337   161.[illegible]7        2.946   .177   225.33
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SEISMIC MAP OF CONTINENTAL U.S.

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
2451	100.50 - 101.00	29.00 - 29.50	3.028	.337	151.48	2.946	.177	233.94
2452	100.50 - 101.00	29.50 - 30.00	3.028	.337	143.53	2.946	.177	243.49
2453	100.50 - 101.00	30.00 - 30.50	3.028	.337	138.56	2.946	.177	254.39
2454	100.50 - 101.00	30.50 - 31.00	3.176	.273	150.80	2.946	.177	267.14
2455	100.50 - 101.00	31.00 - 31.50	3.427	.191	187.24	2.946	.177	282.10
2456	100.50 - 101.00	31.50 - 32.00	3.535	.166	190.05	2.884	.114	280.27
2457	100.50 - 101.00	32.00 - 32.50	3.558	.159	181.48	2.923	.074	280.02
2458	100.50 - 101.00	32.50 - 33.00	3.565	.150	170.71	2.957	.041	275.72
2459	100.50 - 101.00	33.00 - 33.50	3.579	.157	159.51	2.962	.034	249.85
2460	100.50 - 101.00	33.50 - 34.00	3.584	.151	143.97	2.981	.012	224.61
2461	100.50 - 101.00	34.00 - 34.50	3.584	.151	123.92	2.981	.012	199.98
2462	100.50 - 101.00	34.50 - 35.00	3.577	.158	96.44	2.754	.184	130.79
2463	100.50 - 101.00	35.00 - 35.50	3.595	.169	75.15	2.881	.065	109.96
2464	100.50 - 101.00	35.50 - 36.00	3.652	.156	89.51	3.882	.252	226.87
2465	100.50 - 101.00	36.00 - 36.50	3.672	.163	117.01	3.946	.235	256.79
2466	100.50 - 101.00	36.50 - 37.00	3.683	.150	137.77	3.955	.227	255.90
2467	100.50 - 101.00	37.00 - 37.50	3.728	.145	151.93	3.955	.227	244.98
2468	100.50 - 101.00	37.50 - 38.00	3.734	.137	146.93	3.954	.227	233.07
2469	100.50 - 101.00	38.00 - 38.50	3.729	.143	169.13	3.954	.227	223.89
2470	100.50 - 101.00	38.50 - 39.00	3.765	.141	189.58	3.998	.229	225.53
2471	100.50 - 101.00	39.00 - 39.50	3.753	.130	194.70	3.998	.229	220.30
2472	100.50 - 101.00	39.50 - 40.00	3.640	.135	172.75	4.021	.224	220.09
2473	100.50 - 101.00	40.00 - 40.50	3.590	.095	171.17	4.021	.224	220.09
2474	100.50 - 101.00	40.50 - 41.00	3.564	.085	173.16	4.016	.232	221.67
2475	100.50 - 101.00	41.00 - 41.50	3.557	.091	172.15	4.013	.237	222.38
2476	100.50 - 101.00	41.50 - 42.00	3.536	.077	162.55	4.002	.234	216.35
2477	100.50 - 101.00	42.00 - 42.50	3.529	.084	149.20	3.999	.239	201.75
2478	100.50 - 101.00	42.50 - 43.00	3.529	.084	125.39	3.999	.239	190.09
2479	100.50 - 101.00	43.00 - 43.50	3.536	.077	99.19	4.022	.234	208.55
2480	100.50 - 101.00	43.50 - 44.00	3.436	.122	107.00	3.996	.239	229.72
2481	100.50 - 101.00	44.00 - 44.50	3.312	.218	111.12	3.377	.268	147.12
2482	100.50 - 101.00	44.50 - 45.00	3.274	.194	124.40	3.190	.210	141.92
2483	100.50 - 101.00	45.00 - 45.50	3.274	.194	141.05	3.190	.210	169.02
2484	100.50 - 101.00	45.50 - 46.00	3.347	.133	181.34	3.190	.210	197.61
2485	100.50 - 101.00	46.00 - 46.50	3.304	.393	168.03	3.190	.210	227.01

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
2486	100.50 - 101.00	46.50 - 47.00	3.304	.393	173.96	3.190	.210	256.98
2487	100.50 - 101.00	47.00 - 47.50	3.239	.396	174.51	2.954	.145	257.92
2488	100.50 - 101.00	47.50 - 48.00	3.194	.408	169.28	2.954	.145	285.48
2489	100.50 - 101.00	48.00 - 48.50	3.162	.435	162.71	2.446	.074	307.71
2490	100.50 - 101.00	48.50 - 49.00	3.082	.490	148.04	2.746	.503	286.96
2491	100.50 - 101.00	49.00 - 49.50	3.082	.490	144.75	2.746	.503	297.15
2492	100.50 - 101.00	49.50 - 50.00	3.082	.490	144.61	2.746	.503	310.85
2493	101.00 - 101.50	27.00 - 27.50	2.877	.462	161.88	3.225	.226	194.42
2494	101.00 - 101.50	27.50 - 28.00	2.877	.462	147.66	3.199	.209	188.86
2495	101.00 - 101.50	28.00 - 28.50	2.877	.462	134.52	3.199	.209	190.90
2496	101.00 - 101.50	28.50 - 29.00	2.877	.462	122.79	3.199	.209	193.41
2497	101.00 - 101.50	29.00 - 29.50	2.877	.462	112.89	3.199	.209	195.71
2498	101.00 - 101.50	29.50 - 30.00	2.877	.462	105.33	3.199	.209	198.70
2499	101.00 - 101.50	30.00 - 30.50	2.877	.462	100.66	3.199	.209	203.28
2500	101.00 - 101.50	30.50 - 31.00	3.123	.288	127.93	3.199	.209	210.02
2501	101.00 - 101.50	31.00 - 31.50	3.399	.203	169.37	3.199	.209	219.21
2502	101.00 - 101.50	31.50 - 32.00	3.519	.163	179.59	3.210	.207	228.65
2503	101.00 - 101.50	32.00 - 32.50	3.543	.154	174.22	3.231	.206	232.00
2504	101.00 - 101.50	32.50 - 33.00	3.551	.144	165.96	3.240	.207	234.32
2505	101.00 - 101.50	33.00 - 33.50	3.565	.150	156.49	3.341	.095	264.29
2506	101.00 - 101.50	33.50 - 34.00	3.571	.144	141.80	3.223	.189	220.26
2507	101.00 - 101.50	34.00 - 34.50	3.571	.144	120.20	3.223	.189	205.77
2508	101.00 - 101.50	34.50 - 35.00	3.564	.152	84.08	2.922	.071	137.60
2509	101.00 - 101.50	35.00 - 35.50	3.578	.161	31.73	2.981	.012	100.24
2510	101.00 - 101.50	35.50 - 36.00	3.636	.151	48.49	3.892	.246	119.92
2511	101.00 - 101.50	36.00 - 36.50	3.656	.157	105.84	3.955	.227	228.77
2512	101.00 - 101.50	36.50 - 37.00	3.759	.152	137.46	3.991	.221	235.70
2513	101.00 - 101.50	37.00 - 37.50	3.798	.148	157.15	3.991	.221	222.70
2514	101.00 - 101.50	37.50 - 38.00	3.803	.141	165.52	3.991	.221	209.01
2515	101.00 - 101.50	38.00 - 38.50	3.803	.141	177.05	3.991	.221	201.32
2516	101.00 - 101.50	38.50 - 39.00	3.833	.140	190.94	4.032	.218	203.37
2517	101.00 - 101.50	39.00 - 39.50	3.823	.130	198.69	4.032	.218	198.09
2518	101.00 - 101.50	39.50 - 40.00	3.691	.109	185.15	4.053	.216	198.23
2519	101.00 - 101.50	40.00 - 40.50	3.638	.084	182.11	4.053	.216	199.41
2520	101.00 - 101.50	40.50 - 41.00	3.612	.083	181.05	4.038	.229	201.42

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*                              * SEISMIC MAP OF CONTINENTAL U.S. *                              *
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*  GFID    LONG1 - LONG2       LAT1 - LAT2        A(H)    O(H)    R(H)       A(N)    O(N)    R(N) *
*************************************************************************************************
*                                                                                               *
*  2521   101.00 - 101.50    41.00 - 41.50      3.605   .093   178.89      4.035   .233   204.30 *
*  2522   101.00 - 101.50    41.50 - 42.00      3.577   .098   168.81      4.025   .230   198.45 *
*  2523   101.00 - 101.50    42.00 - 42.50      3.571   .107   153.08      4.022   .234   171.43 *
*  2524   101.00 - 101.50    42.50 - 43.00      3.571   .107   120.20      4.022   .234   133.93 *
*  2525   101.00 - 101.50    43.00 - 43.50      3.537   .075    48.46      4.058   .230   178.04 *
*  2526   101.00 - 101.50    43.50 - 44.00      3.428   .128    86.84      4.059   .235   216.89 *
*  2527   101.00 - 101.50    44.00 - 44.50      3.304   .218   103.42      3.579   .258   166.00 *
*  2528   101.00 - 101.50    44.50 - 45.00      3.274   .194   123.80      3.447   .242   173.60 *
*  2529   101.00 - 101.50    45.00 - 45.50      3.274   .194   142.16      3.421   .261   197.54 *
*  2530   101.00 - 101.50    45.50 - 46.00      3.347   .133   182.02      3.421   .261   224.20 *
*  2531   101.00 - 101.50    46.00 - 46.50      3.304   .393   166.49      3.421   .261   248.82 *
*  2532   101.00 - 101.50    46.50 - 47.00      3.304   .393   170.18      3.421   .261   271.53 *
*  2533   101.00 - 101.50    47.00 - 47.50      3.239   .396   167.06      3.271   .212   274.73 *
*  2534   101.00 - 101.50    47.50 - 48.00      3.194   .408   158.55      3.271   .212   291.91 *
*  2535   101.00 - 101.50    48.00 - 48.50      3.162   .435   149.58      2.940   .316   276.12 *
*  2536   101.00 - 101.50    48.50 - 49.00      3.046   .489   125.93      2.746   .503   264.52 *
*  2537   101.00 - 101.50    49.00 - 49.50      2.993   .552   117.03      2.746   .503   275.54 *
*  2538   101.00 - 101.50    49.50 - 50.00      2.993   .552   116.60      2.746   .503   290.26 *
*  2539   101.50 - 102.00    27.00 - 27.50      2.877   .462   152.50      3.225   .226   155.94 *
*  2540   101.50 - 102.00    27.50 - 28.00      2.877   .462   137.33      3.225   .226   159.54 *
*  2541   101.50 - 102.00    28.00 - 28.50      2.877   .462   123.12      3.225   .226   168.15 *
*  2542   101.50 - 102.00    28.50 - 29.00      2.877   .462   110.20      3.225   .226   172.79 *
*  2543   101.50 - 102.00    29.00 - 29.50      2.877   .462    99.08      3.225   .226   175.02 *
*  2544   101.50 - 102.00    29.50 - 30.00      2.877   .462    90.39      3.225   .226   177.35 *
*  2545   101.50 - 102.00    30.00 - 30.50      2.877   .462    84.86      3.225   .226   181.19 *
*  2546   101.50 - 102.00    30.50 - 31.00      3.123   .288   109.54      3.225   .226   187.26 *
*  2547   101.50 - 102.00    31.00 - 31.50      3.474   .161   151.95      3.225   .226   195.93 *
*  2548   101.50 - 102.00    31.50 - 32.00      3.572   .153   159.91      3.234   .225   206.10 *
*  2549   101.50 - 102.00    32.00 - 32.50      3.591   .154   157.20      3.299   .258   213.66 *
*  2550   101.50 - 102.00    32.50 - 33.00      3.597   .148   151.54      3.307   .259   216.63 *
*  2551   101.50 - 102.00    33.00 - 33.50      3.614   .152   144.06      3.407   .140   245.85 *
*  2552   101.50 - 102.00    33.50 - 34.00      3.618   .149   132.93      3.294   .245   206.92 *
*  2553   101.50 - 102.00    34.00 - 34.50      3.618   .149   117.13      3.294   .245   195.36 *
*  2554   101.50 - 102.00    34.50 - 35.00      3.647   .143    97.60      3.101   .102   153.85 *
*  2555   101.50 - 102.00    35.00 - 35.50      3.616   .181    72.81      3.294   .099   151.48 *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
2556	101.50 - 102.00	35.50 - 36.00	3.622	.176	78.61	3.936	.244	208.50
2557	101.50 - 102.00	36.00 - 36.50	3.640	.188	97.77	3.991	.221	225.01
2558	101.50 - 102.00	36.50 - 37.00	3.798	.170	123.37	4.044	.227	220.19
2559	101.50 - 102.00	37.00 - 37.50	3.820	.179	139.27	4.044	.227	202.65
2560	101.50 - 102.00	37.50 - 38.00	3.823	.178	148.84	4.044	.227	180.97
2561	101.50 - 102.00	38.00 - 38.50	3.823	.178	158.16	4.044	.227	182.05
2562	101.50 - 102.00	38.50 - 39.00	3.835	.188	168.69	4.084	.215	185.55
2563	101.50 - 102.00	39.00 - 39.50	3.778	.155	176.50	4.084	.215	179.63
2564	101.50 - 102.00	39.50 - 40.00	3.682	.100	175.59	4.093	.211	177.63
2565	101.50 - 102.00	40.00 - 40.50	3.621	.073	178.04	4.093	.211	179.68
2566	101.50 - 102.00	40.50 - 41.00	3.594	.074	176.09	4.079	.221	183.88
2567	101.50 - 102.00	41.00 - 41.50	3.586	.085	173.26	4.072	.227	189.28
2568	101.50 - 102.00	41.50 - 42.00	3.556	.093	162.18	4.058	.226	185.93
2569	101.50 - 102.00	42.00 - 42.50	3.549	.102	146.36	4.055	.230	153.76
2570	101.50 - 102.00	42.50 - 43.00	3.549	.102	121.98	4.055	.230	63.10
2571	101.50 - 102.00	43.00 - 43.50	3.546	.066	91.25	4.065	.220	154.78
2572	101.50 - 102.00	43.50 - 44.00	3.447	.115	57.09	4.062	.231	179.06
2573	101.50 - 102.00	44.00 - 44.50	3.324	.219	97.41	3.587	.246	146.15
2574	101.50 - 102.00	44.50 - 45.00	3.297	.195	120.23	3.447	.2[illegible]2	161.29
2575	101.50 - 102.00	45.00 - 45.50	3.286	.194	138.66	3.421	.261	187.45
2576	101.50 - 102.00	45.50 - 46.00	3.366	.114	177.61	3.421	.261	214.53
2577	101.50 - 102.00	46.00 - 46.50	3.313	.391	159.26	3.421	.261	238.73
2578	101.50 - 102.00	46.50 - 47.00	3.313	.391	161.10	3.421	.261	260.53
2579	101.50 - 102.00	47.00 - 47.50	3.251	.390	155.10	3.271	.212	260.92
2580	101.50 - 102.00	47.50 - 48.00	3.209	.398	144.74	3.271	.212	277.05
2581	101.50 - 102.00	48.00 - 48.50	3.183	.416	135.35	2.940	.316	255.67
2582	101.50 - 102.00	48.50 - 49.00	3.046	.489	111.68	2.744	.503	242.22
2583	101.50 - 102.00	49.00 - 49.50	2.993	.552	102.99	2.744	.503	254.21
2584	101.50 - 102.00	49.50 - 50.00	2.993	.552	102.70	2.744	.503	270.10
2585	102.00 - 102.50	28.00 - 28.50	2.877	.462	112.83	3.225	.226	145.36
2586	102.00 - 102.50	28.50 - 29.00	2.877	.462	98.62	3.225	.226	151.90
2587	102.00 - 102.50	29.00 - 29.50	2.877	.462	86.06	3.225	.226	153.86
2588	102.00 - 102.50	29.50 - 30.00	2.877	.462	75.91	3.225	.226	155.87
2589	102.00 - 102.50	30.00 - 30.50	2.943	.430	73.09	3.250	.243	162.39
2590	102.00 - 102.50	30.50 - 31.00	3.400	.159	115.82	3.250	.243	168.17

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                              * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

  2591   102.00 - 102.50    31.00 - 31.50      3.591    .120   135.54      3.453    .147   222.21
  2592   102.00 - 102.50    31.50 - 32.00      3.764    .148   160.29      3.461    .136   231.79
  2593   102.00 - 102.50    32.00 - 32.50      3.779    .143   159.19      3.513    .132   239.94
  2594   102.00 - 102.50    32.50 - 33.00      3.783    .138   154.46      3.535    .134   243.19
  2595   102.00 - 102.50    33.00 - 33.50      3.796    .135   148.32      3.592    .123   254.23
  2596   102.00 - 102.50    33.50 - 34.00      3.799    .131   139.62      3.541    .130   232.92
  2597   102.00 - 102.50    34.00 - 34.50      3.799    .131   128.78      3.541    .130   221.77
  2598   102.00 - 102.50    34.50 - 35.00      3.818    .129   118.97      3.415    .103   191.65
  2599   102.00 - 102.50    35.00 - 35.50      3.720    .149    95.39      3.562    .150   194.98
  2600   102.00 - 102.50    35.50 - 36.00      3.723    .147    91.05      3.983    .260   218.53
  2601   102.00 - 102.50    36.00 - 36.50      3.733    .156    90.20      4.041    .228   215.02
  2602   102.00 - 102.50    36.50 - 37.00      4.033    .153   135.54      4.126    .217   198.02
  2603   102.00 - 102.50    37.00 - 37.50      4.051    .145   154.17      4.126    .217   181.33
  2604   102.00 - 102.50    37.50 - 38.00      4.053    .141   165.45      4.126    .217   125.20
  2605   102.00 - 102.50    38.00 - 38.50      4.053    .141   175.83      4.126    .217   164.01
  2606   102.00 - 102.50    38.50 - 39.00      3.802    .181   152.57      4.147    .222   164.10
  2607   102.00 - 102.50    39.00 - 39.50      3.739    .147   157.86      4.147    .222   157.67
  2608   102.00 - 102.50    39.50 - 40.00      3.621    .129   150.91      4.152    .221   155.39
  2609   102.00 - 102.50    40.00 - 40.50      3.515    .160   142.35      4.152    .221   159.10
  2610   102.00 - 102.50    40.50 - 41.00      3.495    .143   139.97      4.144    .224   167.67
  2611   102.00 - 102.50    41.00 - 41.50      3.488    .143   138.21      4.071    .215   167.08
  2612   102.00 - 102.50    41.50 - 42.00      3.458    .124   129.11      4.068    .217   176.62
  2613   102.00 - 102.50    42.00 - 42.50      3.443    .127   116.01      4.065    .220   162.10
  2614   102.00 - 102.50    42.50 - 43.00      3.411    .100    99.49      4.065    .220   132.51
  2615   102.00 - 102.50    43.00 - 43.50      3.517    .057   107.12      4.112    .221   167.86
  2616   102.00 - 102.50    43.50 - 44.00      3.413    .099    89.80      4.077    .229   107.98
  2617   102.00 - 102.50    44.00 - 44.50      3.288    .194    95.83      3.639    .230   136.39
  2618   102.00 - 102.50    44.50 - 45.00      3.288    .194   118.06      3.516    .224   159.52
  2619   102.00 - 102.50    45.00 - 45.50      3.277    .194   137.13      3.495    .239   188.96
  2620   102.00 - 102.50    45.50 - 46.00      3.351    .129   174.22      3.495    .239   216.53
  2621   102.00 - 102.50    46.00 - 46.50      3.306    .393   156.62      3.472    .257   236.24
  2622   102.00 - 102.50    46.50 - 47.00      3.306    .393   156.38      3.472    .257   256.95
  2623   102.00 - 102.50    47.00 - 47.50      3.242    .395   146.43      3.333    .221   255.10
  2624   102.00 - 102.50    47.50 - 48.00      3.209    .398   133.35      3.333    .221   270.50
  2625   102.00 - 102.50    48.00 - 48.50      3.183    .416   121.22      2.940    .316   235.06
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*                            * SEISMIC MAP OF CONTINENTAL U.S. *                          *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)    R(H)       A(N)   C(N)    R(N)    *
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*
*  2626   102.00 - 102.50   48.50 - 49.00     3.046   .489    97.26     2.746   .503   220.10   *
*  2627   102.00 - 102.50   49.00 - 49.50     2.993   .552    89.11     2.746   .503   233.23   *
*  2628   102.00 - 102.50   49.50 - 50.00     2.993   .552    89.06     2.746   .503   250.46   *
*  2629   102.50 - 103.00   28.00 - 28.50     2.877   .462   103.96     3.225   .226   128.22   *
*  2630   102.50 - 103.00   28.50 - 29.00     2.877   .462    88.40     3.225   .226   132.17   *
*  2631   102.50 - 103.00   29.00 - 29.50     2.877   .462    74.22     3.225   .226   132.86   *
*  2632   102.50 - 103.00   29.50 - 30.00     2.877   .462    62.25     3.225   .226   134.54   *
*  2633   102.50 - 103.00   30.00 - 30.50     3.712   .299   132.10     3.250   .243   140.83   *
*  2634   102.50 - 103.00   30.50 - 31.00     3.830   .243   135.93     3.250   .243   146.87   *
*  2635   102.50 - 103.00   31.00 - 31.50     3.899   .211   141.49     3.453   .147   197.84   *
*  2636   102.50 - 103.00   31.50 - 32.00     3.973   .222   152.49     3.461   .136   209.50   *
*  2637   102.50 - 103.00   32.00 - 32.50     3.983   .215   151.75     3.513   .132   220.97   *
*  2638   102.50 - 103.00   32.50 - 33.00     3.987   .211   147.73     3.712   .210   239.01   *
*  2639   102.50 - 103.00   33.00 - 33.50     3.997   .205   142.82     3.843   .130   257.95   *
*  2640   102.50 - 103.00   33.50 - 34.00     4.002   .198   136.49     3.830   .121   245.12   *
*  2641   102.50 - 103.00   34.00 - 34.50     4.010   .197   130.38     3.836   .121   231.96   *
*  2642   102.50 - 103.00   34.50 - 35.00     4.023   .194   125.90     3.792   .127   218.89   *
*  2643   102.50 - 103.00   35.00 - 35.50     3.983   .169   112.99     3.840   .140   202.87   *
*  2644   102.50 - 103.00   35.50 - 36.00     3.986   .166   101.97     4.094   .218   202.73   *
*  2645   102.50 - 103.00   36.00 - 36.50     3.993   .166    73.24     4.124   .218   183.84   *
*  2646   102.50 - 103.00   36.50 - 37.00     4.041   .154   123.77     4.161   .226   183.11   *
*  2647   102.50 - 103.00   37.00 - 37.50     4.041   .154   140.70     4.161   .226   172.51   *
*  2648   102.50 - 103.00   37.50 - 38.00     4.044   .151   151.60     4.164   .226   158.29   *
*  2649   102.50 - 103.00   38.00 - 38.50     4.044   .151   161.12     4.164   .226   153.75   *
*  2650   102.50 - 103.00   38.50 - 39.00     3.779   .194   136.55     4.181   .232   146.80   *
*  2651   102.50 - 103.00   39.00 - 39.50     3.713   .167   139.76     4.181   .232   136.99   *
*  2652   102.50 - 103.00   39.50 - 40.00     3.582   .214   128.89     4.191   .235   134.12   *
*  2653   102.50 - 103.00   40.00 - 40.50     3.422   .331   111.75     4.191   .235   138.97   *
*  2654   102.50 - 103.00   40.50 - 41.00     3.404   .316   111.40     4.184   .237   150.97   *
*  2655   102.50 - 103.00   41.00 - 41.50     3.397   .315   111.69     4.119   .226   157.02   *
*  2656   102.50 - 103.00   41.50 - 42.00     3.370   .297   105.56     4.136   .213   178.58   *
*  2657   102.50 - 103.00   42.00 - 42.50     3.354   .295    90.97     4.130   .219   182.13   *
*  2658   102.50 - 103.00   42.50 - 43.00     3.259   .217    65.64     4.117   .219   179.37   *
*  2659   102.50 - 103.00   43.00 - 43.50     3.316   .200    78.36     4.112   .221   185.51   *
*  2660   102.50 - 103.00   43.50 - 44.00     3.307   .197    76.42     4.077   .229   173.33   *
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                         * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)   B(H)    R(H)       A(N)   B(N)    R(N)

  2661   102.50 - 103.00   44.00 - 44.50     3.299   .195    92.35     3.639   .230   125.40
  2662   102.50 - 103.00   44.50 - 45.00     3.299   .195   113.26     3.516   .224   147.37
  2663   102.50 - 103.00   45.00 - 45.50     3.288   .194   132.80     3.499   .239   180.14
  2664   102.50 - 103.00   45.50 - 46.00     3.370   .110   170.16     3.495   .239   207.78
  2665   102.50 - 103.00   46.00 - 46.50     3.314   .391   150.37     3.472   .257   226.71
  2666   102.50 - 103.00   46.50 - 47.00     3.314   .391   148.77     3.472   .257   245.82
  2667   102.50 - 103.00   47.00 - 47.50     3.253   .389   136.52     3.333   .221   240.44
  2668   102.50 - 103.00   47.50 - 48.00     3.222   .391   121.13     3.333   .221   254.28
  2669   102.50 - 103.00   48.00 - 48.50     3.183   .416   106.23     2.940   .316   214.13
  2670   102.50 - 103.00   48.50 - 49.00     3.046   .489    82.47     2.746   .503   198.24
  2671   102.50 - 103.00   49.00 - 49.50     2.993   .552    75.44     2.746   .503   212.72
  2672   102.50 - 103.00   49.50 - 50.00     2.993   .552    75.80     2.746   .503   231.48
  2673   103.00 - 103.50   28.00 - 28.50     2.877   .462    96.89     3.368   .135   135.25
  2674   103.00 - 103.50   28.50 - 29.00     2.877   .462    80.01     3.368   .135   130.11
  2675   103.00 - 103.50   29.00 - 29.50     2.877   .462    64.14     3.368   .135   130.38
  2676   103.00 - 103.50   29.50 - 30.00     2.877   .462    50.02     3.368   .135   132.86
  2677   103.00 - 103.50   30.00 - 30.50     3.712   .299   105.60     3.385   .141   138.14
  2678   103.00 - 103.50   30.50 - 31.00     3.830   .243   106.43     3.385   .141   145.29
  2679   103.00 - 103.50   31.00 - 31.50     3.899   .211   118.60     3.490   .140   174.26
  2680   103.00 - 103.50   31.50 - 32.00     3.962   .228   135.15     3.497   .132   188.08
  2681   103.00 - 103.50   32.00 - 32.50     3.973   .221   138.23     3.533   .128   199.25
  2682   103.00 - 103.50   32.50 - 33.00     3.977   .216   135.17     3.808   .138   249.56
  2683   103.00 - 103.50   33.00 - 33.50     3.987   .210   130.34     3.893   .120   254.85
  2684   103.00 - 103.50   33.50 - 34.00     3.993   .203   124.30     3.835   .122   229.73
  2685   103.00 - 103.50   34.00 - 34.50     4.018   .199   119.89     3.855   .130   218.24
  2686   103.00 - 103.50   34.50 - 35.00     4.030   .195   116.23     3.826   .132   204.79
  2687   103.00 - 103.50   35.00 - 35.50     3.990   .172   103.32     3.916   .135   198.71
  2688   103.00 - 103.50   35.50 - 36.00     3.993   .169    69.68     4.134   .223   190.63
  2689   103.00 - 103.50   36.00 - 36.50     4.000   .169    98.75     4.159   .226   130.18
  2690   103.00 - 103.50   36.50 - 37.00     4.013   .161   115.30     4.166   .226   163.73
  2691   103.00 - 103.50   37.00 - 37.50     4.011   .164   128.22     4.166   .226   156.90
  2692   103.00 - 103.50   37.50 - 38.00     4.013   .161   138.19     4.169   .226   149.60
  2693   103.00 - 103.50   38.00 - 38.50     4.013   .161   147.18     4.169   .226   139.26
  2694   103.00 - 103.50   38.50 - 39.00     3.725   .184   121.28     4.186   .231   126.73
  2695   103.00 - 103.50   39.00 - 39.50     3.644   .163   120.88     4.186   .231   112.02
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                              * SEISMIC MAP OF CONTINENTAL U.S. *

  GFID     LONG1 - LONG2       LAT1 - LAT2          A(H)    Q(H)     R(H)         A(N)    Q(N)     R(N)

  2696    103.00 - 103.50    39.50 - 40.00         3.554    .183   114.85        4.195    .234   106.71
  2697    103.00 - 103.50    40.00 - 40.50         3.411    .318    99.81        4.195    .234   113.10
  2698    103.00 - 103.50    40.50 - 41.00         3.393    .303   100.20        4.189    .237   129.89
  2699    103.00 - 103.50    41.00 - 41.50         3.385    .301   101.87        4.125    .225   142.24
  2700    103.00 - 103.50    41.50 - 42.00         3.357    .281    97.35        4.144    .209   169.95
  2701    103.00 - 103.50    42.00 - 42.50         3.341    .278    81.03        4.130    .219   182.60
  2702    103.00 - 103.50    42.50 - 43.00         3.238    .191    31.50        4.117    .219   190.29
  2703    103.00 - 103.50    43.00 - 43.50         3.390    .089    83.27        4.138    .221   200.48
  2704    103.00 - 103.50    43.50 - 44.00         3.373    .106    52.43        4.105    .228   196.13
  2705    103.00 - 103.50    44.00 - 44.50         3.359    .121    87.67        3.724    .211    88.72
  2706    103.00 - 103.50    44.50 - 45.00         3.359    .121   120.29        3.554    .225   143.51
  2707    103.00 - 103.50    45.00 - 45.50         3.339    .141   146.59        3.535    .239   178.95
  2708    103.00 - 103.50    45.50 - 46.00         3.339    .141   163.75        3.535    .239   205.70
  2709    103.00 - 103.50    46.00 - 46.50         3.301    .395   147.34        3.515    .256   224.15
  2710    103.00 - 103.50    46.50 - 47.00         3.301    .395   143.78        3.515    .256   241.39
  2711    103.00 - 103.50    47.00 - 47.50         3.253    .389   128.91        3.385    .231   233.40
  2712    103.00 - 103.50    47.50 - 48.00         3.222    .391   109.65        3.333    .221   236.88
  2713    103.00 - 103.50    48.00 - 48.50         3.183    .416    90.24        2.940    .316   192.67
  2714    103.00 - 103.50    48.50 - 49.00         3.046    .489    66.88        2.746    .503   176.71
  2715    103.00 - 103.50    49.00 - 49.50         2.993    .552    62.10        2.746    .503   192.82
  2716    103.00 - 103.50    49.50 - 50.00         2.993    .552    63.11        2.746    .503   213.33
  2717    103.50 - 104.00    28.00 - 28.50         2.877    .462    92.01        3.368    .135   116.43
  2718    103.50 - 104.00    28.50 - 29.00         2.915    .440    76.44        3.368    .135    95.19
  2719    103.50 - 104.00    29.00 - 29.50         2.915    .440    58.81        3.368    .135   104.46
  2720    103.50 - 104.00    29.50 - 30.00         2.915    .440    42.18        3.368    .135   109.37
  2721    103.50 - 104.00    30.00 - 30.50         3.719    .291    77.92        3.385    .141   113.27
  2722    103.50 - 104.00    30.50 - 31.00         3.824    .241    65.49        3.385    .141   120.86
  2723    103.50 - 104.00    31.00 - 31.50         3.894    .208    91.80        3.490    .140   150.60
  2724    103.50 - 104.00    31.50 - 32.00         3.958    .226   119.85        3.497    .132   167.54
  2725    103.50 - 104.00    32.00 - 32.50         3.969    .218   126.19        3.533    .128   182.49
  2726    103.50 - 104.00    32.50 - 33.00         3.973    .214   123.28        3.808    .138   233.54
  2727    103.50 - 104.00    33.00 - 33.50         3.976    .210   116.94        3.893    .120   239.74
  2728    103.50 - 104.00    33.50 - 34.00         3.982    .202   110.39        3.848    .126   215.17
  2729    103.50 - 104.00    34.00 - 34.50         4.008    .197   105.99        3.864    .133   202.95
  2730    103.50 - 104.00    34.50 - 35.00         4.021    .194   103.19        3.834    .132   188.36
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *                                 *
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*  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    O(H)    R(H)        A(N)    B(N)    R(N)  *
*****************************************************************************************************
*                                                                                                   *
*  2731   103.50 - 104.00    35.00 - 35.50      3.981   .169    94.99       3.924   .135   182.58  *
*  2732   103.50 - 104.00    35.50 - 36.00      3.983   .166    90.82       4.139   .222   180.90  *
*  2733   103.50 - 104.00    36.00 - 36.50      3.991   .165    96.96       4.164   .226   160.08  *
*  2734   103.50 - 104.00    36.50 - 37.00      4.013   .163   108.08       4.177   .228   145.24  *
*  2735   103.50 - 104.00    37.00 - 37.50      4.010   .167   118.68       4.177   .228   132.51  *
*  2736   103.50 - 104.00    37.50 - 38.00      4.006   .163   128.17       4.179   .228   135.37  *
*  2737   103.50 - 104.00    38.00 - 38.50      4.006   .163   136.88       4.179   .228   126.00  *
*  2738   103.50 - 104.00    38.50 - 39.00      3.714   .177   111.42       4.197   .233   108.65  *
*  2739   103.50 - 104.00    39.00 - 39.50      3.631   .155   109.33       4.200   .238    86.60  *
*  2740   103.50 - 104.00    39.50 - 40.00      3.537   .171   100.89       4.210   .241    78.12  *
*  2741   103.50 - 104.00    40.00 - 40.50      3.372   .286    83.80       4.210   .241    86.49  *
*  2742   103.50 - 104.00    40.50 - 41.00      3.350   .268    85.17       4.203   .243   110.33  *
*  2743   103.50 - 104.00    41.00 - 41.50      3.342   .265    89.41       4.143   .230   130.00  *
*  2744   103.50 - 104.00    41.50 - 42.00      3.309   .241    87.85       4.168   .211   163.09  *
*  2745   103.50 - 104.00    42.00 - 42.50      3.292   .237    79.99       4.154   .220   180.96  *
*  2746   103.50 - 104.00    42.50 - 43.00      3.157   .124    57.23       4.142   .219   193.38  *
*  2747   103.50 - 104.00    43.00 - 43.50      3.418   .079    93.08       4.148   .221   203.94  *
*  2748   103.50 - 104.00    43.50 - 44.00      3.402   .094    86.07       4.114   .230   203.67  *
*  2749   103.50 - 104.00    44.00 - 44.50      3.389   .108    54.96       3.748   .212   146.14  *
*  2750   103.50 - 104.00    44.50 - 45.00      3.389   .108   114.42       3.554   .225   145.52  *
*  2751   103.50 - 104.00    45.00 - 45.50      3.371   .126   142.13       3.535   .239   173.27  *
*  2752   103.50 - 104.00    45.50 - 46.00      3.371   .126   157.60       3.535   .239   198.15  *
*  2753   103.50 - 104.00    46.00 - 46.50      3.306   .396   139.92       3.515   .256   214.92  *
*  2754   103.50 - 104.00    46.50 - 47.00      3.306   .396   135.89       3.515   .256   229.32  *
*  2755   103.50 - 104.00    47.00 - 47.50      3.285   .392   123.07       3.385   .231   216.66  *
*  2756   103.50 - 104.00    47.50 - 48.00      3.222   .391    98.97       3.333   .221   217.66  *
*  2757   103.50 - 104.00    48.00 - 48.50      3.183   .416    73.42       2.940   .316   170.51  *
*  2758   103.50 - 104.00    48.50 - 49.00      3.046   .489    49.63       2.896   .343   177.74  *
*  2759   103.50 - 104.00    49.00 - 49.50      2.993   .552    49.42       2.821   .411   187.25  *
*  2760   103.50 - 104.00    49.50 - 50.00      2.993   .552    51.29       2.746   .503   196.25  *
*  2761   104.00 - 104.50    28.00 - 28.50      3.262   .462   159.89       3.199   .209    76.75  *
*  2762   104.00 - 104.50    28.50 - 29.00      3.262   .462   126.40       3.199   .209    24.88  *
*  2763   104.00 - 104.50    29.00 - 29.50      3.262   .462    93.02       3.225   .226    69.56  *
*  2764   104.00 - 104.50    29.50 - 30.00      3.262   .462    60.58       3.225   .226    76.80  *
*  2765   104.00 - 104.50    30.00 - 30.50      3.262   .462    33.79       3.196   .209    72.56  *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
2766	104.00 - 104.50	30.50 - 31.00	3.262	.462	10.58	3.199	.209	80.69
2767	104.00 - 104.50	31.00 - 31.50	3.262	.462	37.41	3.196	.209	97.50
2768	104.00 - 104.50	31.50 - 32.00	3.328	.430	75.30	3.196	.209	118.01
2769	104.00 - 104.50	32.00 - 32.50	3.760	.158	147.07	3.268	.156	153.69
2770	104.00 - 104.50	32.50 - 33.00	3.835	.149	160.39	3.326	.142	172.22
2771	104.00 - 104.50	33.00 - 33.50	3.981	.204	170.68	3.114	.188	177.54
2772	104.00 - 104.50	33.50 - 34.00	4.301	.206	163.80	3.236	.123	166.51
2773	104.00 - 104.50	34.00 - 34.50	4.304	.201	146.81	3.620	.180	176.80
2774	104.00 - 104.50	34.50 - 35.00	4.308	.196	136.49	3.780	.139	171.97
2775	104.00 - 104.50	35.00 - 35.50	4.312	.191	136.79	3.783	.133	151.77
2776	104.00 - 104.50	35.50 - 36.00	4.321	.190	134.55	3.783	.133	133.36
2777	104.00 - 104.50	36.00 - 36.50	4.339	.183	124.80	3.783	.133	110.80
2778	104.00 - 104.50	36.50 - 37.00	4.343	.178	150.33	3.839	.140	54.33
2779	104.00 - 104.50	37.00 - 37.50	4.019	.133	141.86	4.089	.218	47.88
2780	104.00 - 104.50	37.50 - 38.00	3.927	.116	154.82	4.121	.218	114.53
2781	104.00 - 104.50	38.00 - 38.50	3.792	.136	153.01	4.112	.209	112.43
2782	104.00 - 104.50	38.50 - 39.00	3.523	.124	124.12	4.108	.211	84.83
2783	104.00 - 104.50	39.00 - 39.50	3.468	.074	111.72	4.099	.215	44.03
2784	104.00 - 104.50	39.50 - 40.00	3.449	.073	96.03	4.015	.209	33.79
2785	104.00 - 104.50	40.00 - 40.50	3.487	.132	89.43	4.030	.222	39.39
2786	104.00 - 104.50	40.50 - 41.00	3.515	.179	103.79	4.027	.226	75.44
2787	104.00 - 104.50	41.00 - 41.50	3.486	.116	117.55	4.053	.229	112.21
2788	104.00 - 104.50	41.50 - 42.00	3.525	.056	130.12	4.060	.223	142.90
2789	104.00 - 104.50	42.00 - 42.50	3.525	.056	127.34	4.022	.229	163.38
2790	104.00 - 104.50	42.50 - 43.00	3.525	.056	121.47	3.480	.210	135.29
2791	104.00 - 104.50	43.00 - 43.50	3.390	.020	114.04	3.285	.188	105.44
2792	104.00 - 104.50	43.50 - 44.00	3.357	.013	103.83	3.251	.213	89.77
2793	104.00 - 104.50	44.00 - 44.50	3.357	.013	85.08	3.251	.213	85.22
2794	104.00 - 104.50	44.50 - 45.00	3.317	.053	122.13	3.251	.213	101.87
2795	104.00 - 104.50	45.00 - 45.50	3.317	.053	170.58	3.446	.278	149.33
2796	104.00 - 104.50	45.50 - 46.00	3.129	.060	183.03	3.302	.243	160.32
2797	104.00 - 104.50	46.00 - 46.50	3.187	.022	178.18	3.302	.243	175.64
2798	104.00 - 104.50	46.50 - 47.00	3.089	.076	155.64	2.940	.316	146.94
2799	104.00 - 104.50	47.00 - 47.50	3.016	.149	119.39	2.746	.503	121.42
2800	104.00 - 104.50	47.50 - 48.00	3.378	.552	113.67	2.746	.503	116.41

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•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
•                                • SEISMIC MAP OF CONTINENTAL U.S. •                          •
•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
•   GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)    C(H)    R(H)    .   A(N)    C(N)    R(N)   •
•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
•                                                                                             •
•   2801   104.00 - 104.50    48.00 - 48.50    3.378   .552    68.90       2.746   .503   121.42  •
•   2802   104.00 - 104.50    48.50 - 49.00    3.378   .552    41.07       2.746   .503   135.33  •
•   2803   104.00 - 104.50    49.00 - 49.50    3.378   .552    62.72       2.746   .503   155.77  •
•   2804   104.00 - 104.50    49.50 - 50.00    3.378   .552    68.35       2.746   .503   180.54  •
•   2805   104.50 - 105.00    28.00 - 28.50    3.262   .462   160.59       3.199   .209    86.80  •
•   2806   104.50 - 105.00    28.50 - 29.00    3.262   .462   126.89       3.199   .209    63.25  •
•   2807   104.50 - 105.00    29.00 - 29.50    3.262   .462    92.66       3.225   .226    66.25  •
•   2808   104.50 - 105.00    29.50 - 30.00    3.262   .462    56.27       3.225   .226    56.62  •
•   2809   104.50 - 105.00    30.00 - 30.50    3.262   .462    19.29       3.199   .209    43.64  •
•   2810   104.50 - 105.00    30.50 - 31.00    3.262   .462    30.98       3.199   .209    57.38  •
•   2811   104.50 - 105.00    31.00 - 31.50    3.262   .462    47.51       3.199   .209    79.44  •
•   2812   104.50 - 105.00    31.50 - 32.00    4.097   .299   149.25       3.199   .209   101.73  •
•   2813   104.50 - 105.00    32.00 - 32.50    4.203   .248   174.39       3.268   .156   136.14  •
•   2814   104.50 - 105.00    32.50 - 33.00    4.240   .225   167.67       3.326   .142   156.96  •
•   2815   104.50 - 105.00    33.00 - 33.50    4.296   .250   158.02       3.114   .188   158.11  •
•   2816   104.50 - 105.00    33.50 - 34.00    4.259   .220   135.18       3.221   .144   148.78  •
•   2817   104.50 - 105.00    34.00 - 34.50    4.263   .215   113.34       3.616   .183   159.30  •
•   2818   104.50 - 105.00    34.50 - 35.00    4.267   .210    92.91       3.777   .144   153.38  •
•   2819   104.50 - 105.00    35.00 - 35.50    4.271   .206   107.58       3.787   .137   132.81  •
•   2820   104.50 - 105.00    35.50 - 36.00    4.302   .202   113.07       3.809   .141   117.87  •
•   2821   104.50 - 105.00    36.00 - 36.50    4.322   .191    56.70       3.815   .140   106.70  •
•   2822   104.50 - 105.00    36.50 - 37.00    4.326   .186   113.18       3.909   .140    99.55  •
•   2823   104.50 - 105.00    37.00 - 37.50    3.983   .153   113.87       4.127   .224   104.62  •
•   2824   104.50 - 105.00    37.50 - 38.00    3.877   .163   126.09       4.155   .227   118.70  •
•   2825   104.50 - 105.00    38.00 - 38.50    3.825   .145   130.73       4.146   .220   109.24  •
•   2826   104.50 - 105.00    38.50 - 39.00    3.621   .210   109.58       4.144   .220    82.09  •
•   2827   104.50 - 105.00    39.00 - 39.50    3.586   .180   101.13       4.138   .223    46.36  •
•   2828   104.50 - 105.00    39.50 - 40.00    3.572   .182    79.03       4.064   .214    13.07  •
•   2829   104.50 - 105.00    40.00 - 40.50    3.593   .215    56.44       4.094   .216    30.98  •
•   2830   104.50 - 105.00    40.50 - 41.00    3.576   .221    81.30       4.087   .223    73.14  •
•   2831   104.50 - 105.00    41.00 - 41.50    3.425   .060    93.67       4.105   .228   112.22  •
•   2832   104.50 - 105.00    41.50 - 42.00    3.422   .001    98.27       4.108   .224   143.86  •
•   2833   104.50 - 105.00    42.00 - 42.50    3.422   .001   111.22       4.038   .229   160.39  •
•   2834   104.50 - 105.00    42.50 - 43.00    3.422   .001   125.77       3.543   .197   132.82  •
•   2835   104.50 - 105.00    43.00 - 43.50    3.213   .145   114.03       3.372   .184    98.89  •
•                                                                                             •
•••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
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*                             * SEISMIC MAP OF CONTINENTAL U.S. *                        *
******************************************************************************************
*   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)   C(H)   R(H)       A(N)   C(N)   R(N)   *
******************************************************************************************
*
*   2836   104.50 - 105.00    43.50 - 44.00      3.175  .106   110.60     3.346  .200   78.29  *
*   2837   104.50 - 105.00    44.00 - 44.50      3.175  .106   108.64     3.346  .200   65.14  *
*   2838   104.50 - 105.00    44.50 - 45.00      3.129  .060   123.39     3.317  .220   92.36  *
*   2839   104.50 - 105.00    45.00 - 45.50      3.357  .013   173.65     3.446  .278  141.77  *
*   2840   104.50 - 105.00    45.50 - 46.00      3.175  .106   176.09     3.302  .243  153.02  *
*   2841   104.50 - 105.00    46.00 - 46.50      3.232  .066   174.23     3.302  .243  165.51  *
*   2842   104.50 - 105.00    46.50 - 47.00      3.089  .076   151.98     2.940  .316  129.92  *
*   2843   104.50 - 105.00    47.00 - 47.50      3.016  .149   116.17     2.746  .503   99.50  *
*   2844   104.50 - 105.00    47.50 - 48.00      3.378  .552   108.58     2.746  .503   93.32  *
*   2845   104.50 - 105.00    48.00 - 48.50      3.378  .552    58.83     2.746  .503   99.50  *
*   2846   104.50 - 105.00    48.50 - 49.00      3.378  .552    16.86     2.746  .503  116.06  *
*   2847   104.50 - 105.00    49.00 - 49.50      3.378  .552    53.64     2.746  .503  139.36  *
*   2848   104.50 - 105.00    49.50 - 50.00      3.378  .552    53.41     2.746  .503  166.59  *
*   2849   105.00 - 105.50    28.00 - 28.50      3.262  .462   166.46     3.350  .130  106.03  *
*   2850   105.00 - 105.50    28.50 - 29.00      3.262  .462   134.03     3.350  .130   78.03  *
*   2851   105.00 - 105.50    29.00 - 29.50      3.262  .462   101.88     3.368  .135   57.94  *
*   2852   105.00 - 105.50    29.50 - 30.00      3.262  .462    70.65     3.368  .135   47.69  *
*   2853   105.00 - 105.50    30.00 - 30.50      3.262  .462    50.21     3.350  .130   18.52  *
*   2854   105.00 - 105.50    30.50 - 31.00      3.262  .462    54.82     3.350  .130   47.25  *
*   2855   105.00 - 105.50    31.00 - 31.50      3.262  .462    68.14     3.350  .130   75.89  *
*   2856   105.00 - 105.50    31.50 - 32.00      4.097  .299   159.72     3.350  .130   99.53  *
*   2857   105.00 - 105.50    32.00 - 32.50      4.203  .248   167.80     3.268  .156  118.71  *
*   2858   105.00 - 105.50    32.50 - 33.00      4.240  .225   153.07     3.326  .142  143.34  *
*   2859   105.00 - 105.50    33.00 - 33.50      4.296  .250   138.58     3.114  .188  140.59  *
*   2860   105.00 - 105.50    33.50 - 34.00      4.263  .215   114.18     3.221  .144  130.89  *
*   2861   105.00 - 105.50    34.00 - 34.50      4.267  .210    91.05     3.616  .183  140.48  *
*   2862   105.00 - 105.50    34.50 - 35.00      4.271  .206    39.85     3.777  .144  133.39  *
*   2863   105.00 - 105.50    35.00 - 35.50      4.275  .201    85.17     3.799  .134  110.36  *
*   2864   105.00 - 105.50    35.50 - 36.00      4.302  .202   100.39     3.821  .139   88.80  *
*   2865   105.00 - 105.50    36.00 - 36.50      4.322  .191   100.29     3.826  .139   86.28  *
*   2866   105.00 - 105.50    36.50 - 37.00      4.326  .186    56.83     3.918  .138   99.25  *
*   2867   105.00 - 105.50    37.00 - 37.50      3.983  .153    97.21     4.132  .224  116.21  *
*   2868   105.00 - 105.50    37.50 - 38.00      3.877  .163   110.24     4.160  .227  117.91  *
*   2869   105.00 - 105.50    38.00 - 38.50      3.825  .145   110.14     4.152  .220  106.93  *
*   2870   105.00 - 105.50    38.50 - 39.00      3.621  .210    88.06     4.149  .220   83.52  *
*                                                                                         *
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                        * SEISMIC MAP OF CONTINENTAL U.S. *

  GFID    LONG1 - LONG2     LAT1 - LAT2       A(H)   C(H)    R(H)       A(N)   C(N)    R(N)

  2871   105.00 - 105.50   39.00 - 39.50     3.586   .180    85.68     4.144   .223    53.13
  2872   105.00 - 105.50   39.50 - 40.00     3.572   .182    64.73     4.071   .212    22.81
  2873   105.00 - 105.50   40.00 - 40.50     3.593   .215    20.95     4.070   .209    47.20
  2874   105.00 - 105.50   40.50 - 41.00     3.576   .221    66.96     4.053   .220    76.18
  2875   105.00 - 105.50   41.00 - 41.50     3.429   .059    77.81     4.072   .227   110.26
  2876   105.00 - 105.50   41.50 - 42.00     3.428   .007    61.84     4.074   .223   139.66
  2877   105.00 - 105.50   42.00 - 42.50     3.428   .007    91.30     3.996   .233   153.80
  2878   105.00 - 105.50   42.50 - 43.00     3.428   .007   124.06     3.425   .149   111.97
  2879   105.00 - 105.50   43.00 - 43.50     3.220   .152   118.87     3.280   .183    74.44
  2880   105.00 - 105.50   43.50 - 44.00     3.183   .115   119.43     3.240   .198    46.96
  2881   105.00 - 105.50   44.00 - 44.50     3.183   .115   119.40     3.240   .198    25.36
  2882   105.00 - 105.50   44.50 - 45.00     3.139   .070   124.78     3.195   .218    71.81
  2883   105.00 - 105.50   45.00 - 45.50     3.175   .106   142.49     3.491   .274   140.09
  2884   105.00 - 105.50   45.50 - 46.00     3.209   .000   177.84     3.354   .249   152.62
  2885   105.00 - 105.50   46.00 - 46.50     3.232   .066   169.79     3.302   .243   156.36
  2886   105.00 - 105.50   46.50 - 47.00     3.089   .076   151.12     2.940   .316   113.21
  2887   105.00 - 105.50   47.00 - 47.50     3.016   .149   117.87     2.746   .503    78.31
  2888   105.00 - 105.50   47.50 - 48.00     3.378   .552   113.02     2.746   .503    70.30
  2889   105.00 - 105.50   48.00 - 48.50     3.378   .552    68.58     2.746   .503    78.31
  2890   105.00 - 105.50   48.50 - 49.00     3.378   .552    40.88     2.746   .503    98.51
  2891   105.00 - 105.50   49.00 - 49.50     3.378   .552    59.60     2.746   .503   125.12
  2892   105.00 - 105.50   49.50 - 50.00     3.378   .552    46.87     2.746   .503   154.88
  2893   105.50 - 106.00   28.00 - 28.50     3.262   .462   177.11     3.329   .128   105.23
  2894   105.50 - 106.00   28.50 - 29.00     3.262   .462   147.11     3.329   .128    67.52
  2895   105.50 - 106.00   29.00 - 29.50     3.262   .462   118.96     3.350   .130    22.80
  2896   105.50 - 106.00   29.50 - 30.00     3.262   .462    95.11     3.350   .130    42.10
  2897   105.50 - 106.00   30.00 - 30.50     3.300   .440    83.95     3.350   .130    14.77
  2898   105.50 - 106.00   30.50 - 31.00     3.300   .440    83.89     3.350   .130    30.14
  2899   105.50 - 106.00   31.00 - 31.50     3.300   .440    95.80     3.350   .130    66.93
  2900   105.50 - 106.00   31.50 - 32.00     4.104   .291   166.26     3.350   .130    73.48
  2901   105.50 - 106.00   32.00 - 32.50     4.208   .241   159.91     3.268   .156    97.90
  2902   105.50 - 106.00   32.50 - 33.00     4.245   .220   138.89     3.326   .142   132.25
  2903   105.50 - 106.00   33.00 - 33.50     4.300   .244   119.85     3.114   .188   125.70
  2904   105.50 - 106.00   33.50 - 34.00     4.274   .213    94.64     3.236   .123   112.67
  2905   105.50 - 106.00   34.00 - 34.50     4.278   .208    78.32     3.620   .180   119.47
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                          * SEISMIC MAP OF CONTINENTAL U.S. *

 GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)   C(H)    R(H)        A(N)   C(N)    R(N)

 2506    105.50 - 106.00    34.50 - 35.00      4.282   .204    66.33       3.780   .139   112.70
 2507    105.50 - 106.00    35.00 - 35.50      4.285   .200    62.97       3.799   .134    89.43
 2508    105.50 - 106.00    35.50 - 36.00      4.311   .202    79.44       3.821   .139    43.02
 2509    105.50 - 106.00    36.00 - 36.50      4.322   .191   101.19       3.824   .139    47.30
 2510    105.50 - 106.00    36.50 - 37.00      4.326   .186   106.11       3.918   .138    81.00
 2511    105.50 - 106.00    37.00 - 37.50      3.983   .153    84.10       4.132   .224   103.83
 2512    105.50 - 106.00    37.50 - 38.00      3.877   .163    93.72       4.169   .231   110.82
 2513    105.50 - 106.00    38.00 - 38.50      3.825   .145    87.77       4.161   .224   105.07
 2514    105.50 - 106.00    38.50 - 39.00      3.621   .210    57.68       4.158   .224    85.90
 2515    105.50 - 106.00    39.00 - 39.50      3.586   .180    69.76       4.153   .227    62.79
 2516    105.50 - 106.00    39.50 - 40.00      3.572   .182    69.85       4.083   .216    49.93
 2517    105.50 - 106.00    40.00 - 40.50      3.593   .215    54.58       4.084   .212    64.71
 2518    105.50 - 106.00    40.50 - 41.00      3.576   .221    75.78       4.082   .222    87.90
 2519    105.50 - 106.00    41.00 - 41.50      3.429   .059    69.46       4.095   .231   115.90
 2520    105.50 - 106.00    41.50 - 42.00      3.428   .007    24.01       4.097   .228   141.63
 2521    105.50 - 106.00    42.00 - 42.50      3.428   .007    78.39       4.022   .239   151.24
 2522    105.50 - 106.00    42.50 - 43.00      3.428   .007   121.95       3.520   .184   106.71
 2523    105.50 - 106.00    43.00 - 43.50      3.220   .152   119.07       3.321   .226    64.33
 2524    105.50 - 106.00    43.50 - 44.00      3.183   .115   118.26       3.282   .245    21.27
 2525    105.50 - 106.00    44.00 - 44.50      3.183   .115   112.86       3.282   .245    50.86
 2526    105.50 - 106.00    44.50 - 45.00      3.139   .070   110.23       3.234   .268    79.23
 2527    105.50 - 106.00    45.00 - 45.50      3.359   .061   145.46       3.370   .230   124.90
 2528    105.50 - 106.00    45.50 - 46.00      3.197   .031   150.42       3.358   .249   148.89
 2529    105.50 - 106.00    46.00 - 46.50      3.197   .031   161.05       3.302   .243   148.84
 2530    105.50 - 106.00    46.50 - 47.00      3.089   .076   152.50       2.940   .316    98.17
 2531    105.50 - 106.00    47.00 - 47.50      3.016   .149   123.82       2.744   .503    58.67
 2532    105.50 - 106.00    47.50 - 48.00      3.378   .552   125.14       2.744   .503    47.46
 2533    105.50 - 106.00    48.00 - 48.50      3.378   .552    89.75       2.744   .503    58.67
 2534    105.50 - 106.00    48.50 - 49.00      3.378   .552    71.34       2.744   .503    83.75
 2535    105.50 - 106.00    49.00 - 49.50      3.378   .552    72.91       2.744   .503   113.86
 2536    105.50 - 106.00    49.50 - 50.00      3.378   .552    54.79       2.744   .503   145.93
 2537    106.00 - 106.50    30.00 - 30.50      3.300   .440   112.68       3.350   .130    42.49
 2538    106.00 - 106.50    30.50 - 31.00      3.464   .296   127.12       3.350   .130    54.85
 2539    106.00 - 106.50    31.00 - 31.50      3.464   .296   132.13       3.350   .130    68.57
 2540    106.00 - 106.50    31.50 - 32.00      4.125   .280   168.08       3.350   .130    28.93
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******************************************************************************************
*                         * SEISMIC MAP OF CONTINENTAL U.S. *                            *
******************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)       A(N)   C(N)   R(N)   *
******************************************************************************************
*                                                                                        *
*  2541   106.00 - 106.50   32.00 - 32.50     4.223   .235   152.27      3.287  .137    85.21  *
*  2542   106.00 - 106.50   32.50 - 33.00     4.257   .216   126.69      3.337  .132   127.72  *
*  2543   106.00 - 106.50   33.00 - 33.50     4.302   .243   102.25      3.136  .157   115.84  *
*  2544   106.00 - 106.50   33.50 - 34.00     4.285   .204    74.10      3.236  .123    91.68  *
*  2545   106.00 - 106.50   34.00 - 34.50     4.270   .210    55.92      3.620  .180    88.23  *
*  2546   106.00 - 106.50   34.50 - 35.00     4.273   .205    48.69      3.780  .139    89.83  *
*  2547   106.00 - 106.50   35.00 - 35.50     4.277   .201    26.79      3.799  .134    66.51  *
*  2548   106.00 - 106.50   35.50 - 36.00     4.304   .202    45.51      3.821  .139    65.04  *
*  2549   106.00 - 106.50   36.00 - 36.50     4.315   .192    90.31      3.826  .139    32.24  *
*  2550   106.00 - 106.50   36.50 - 37.00     4.318   .187   109.31      3.920  .135    60.90  *
*  2551   106.00 - 106.50   37.00 - 37.50     3.971   .144    40.03      4.134  .223    80.45  *
*  2552   106.00 - 106.50   37.50 - 38.00     3.860   .153    77.66      4.175  .234    97.61  *
*  2553   106.00 - 106.50   38.00 - 38.50     3.804   .138    68.93      4.167  .227   101.03  *
*  2554   106.00 - 106.50   38.50 - 39.00     3.586   .180    22.41      4.169  .227    84.12  *
*  2555   106.00 - 106.50   39.00 - 39.50     3.600   .181    53.58      4.160  .229    39.23  *
*  2556   106.00 - 106.50   39.50 - 40.00     3.586   .180    72.74      4.091  .218    48.35  *
*  2557   106.00 - 106.50   40.00 - 40.50     3.608   .211    80.51      4.097  .213    75.21  *
*  2558   106.00 - 106.50   40.50 - 41.00     3.633   .245    88.44      4.093  .222    89.91  *
*  2559   106.00 - 106.50   41.00 - 41.50     3.519   .124    82.44      4.105  .231   118.26  *
*  2560   106.00 - 106.50   41.50 - 42.00     3.576   .037    70.36      4.107  .228   142.51  *
*  2561   106.00 - 106.50   42.00 - 42.50     3.576   .037   101.49      4.031  .243   144.97  *
*  2562   106.00 - 106.50   42.50 - 43.00     3.576   .037   132.03      3.551  .202    87.03  *
*  2563   106.00 - 106.50   43.00 - 43.50     3.455   .035   130.14      3.321  .226    61.73  *
*  2564   106.00 - 106.50   43.50 - 44.00     3.428   .007   125.65      3.282  .245    40.65  *
*  2565   106.00 - 106.50   44.00 - 44.50     3.428   .007   113.22      3.282  .245    60.03  *
*  2566   106.00 - 106.50   44.50 - 45.00     3.359   .061    99.26      3.236  .268    85.82  *
*  2567   106.00 - 106.50   45.00 - 45.50     3.359   .061   118.58      3.375  .202   124.14  *
*  2568   106.00 - 106.50   45.50 - 46.00     3.197   .031   133.86      3.365  .216   144.24  *
*  2569   106.00 - 106.50   46.00 - 46.50     3.197   .031   156.07      3.310  .207   141.25  *
*  2570   106.00 - 106.50   46.50 - 47.00     3.089   .076   155.53      3.016  .241    92.06  *
*  2571   106.00 - 106.50   47.00 - 47.50     3.016   .149   132.78      2.896  .343    49.57  *
*  2572   106.00 - 106.50   47.50 - 48.00     3.378   .552   141.56      2.821  .411    27.27  *
*  2573   106.00 - 106.50   48.00 - 48.50     3.378   .552   112.85      2.746  .503    42.76  *
*  2574   106.00 - 106.50   48.50 - 49.00     3.378   .552    96.65      2.746  .503    73.48  *
*  2575   106.00 - 106.50   49.00 - 49.50     3.378   .552    88.87      2.746  .503   106.54  *
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                                 * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)        A(N)    C(N)     R(N)

  2576   106.00 - 106.50    49.50 - 50.00      3.378    .552     72.51      2.746    .503    140.29
  2577   106.50 - 107.00    30.00 - 30.50      3.604    .530    163.17      3.350    .130     70.52
  2578   106.50 - 107.00    30.50 - 31.00      3.710    .418    167.83      3.350    .130     78.22
  2579   106.50 - 107.00    31.00 - 31.50      3.710    .418    165.06      3.350    .130     85.32
  2580   106.50 - 107.00    31.50 - 32.00      4.175    .269    167.13      3.350    .130     77.26
  2581   106.50 - 107.00    32.00 - 32.50      4.251    .224    146.28      3.287    .137    102.93
  2582   106.50 - 107.00    32.50 - 33.00      4.278    .206    118.68      3.337    .132    132.20
  2583   106.50 - 107.00    33.00 - 33.50      4.311    .230     89.63      3.136    .157    112.14
  2584   106.50 - 107.00    33.50 - 34.00      4.287    .203     54.74      3.221    .144     77.46
  2585   106.50 - 107.00    34.00 - 34.50      4.272    .209     28.67      3.616    .183     37.42
  2586   106.50 - 107.00    34.50 - 35.00      4.276    .205     22.25      3.777    .144     75.47
  2587   106.50 - 107.00    35.00 - 35.50      4.279    .201     39.34      3.796    .139     26.63
  2588   106.50 - 107.00    35.50 - 36.00      4.305    .202     33.04      3.821    .139     64.28
  2589   106.50 - 107.00    36.00 - 36.50      4.317    .191     86.32      3.826    .139     50.40
  2590   106.50 - 107.00    36.50 - 37.00      4.320    .187    113.63      3.920    .135     33.91
  2591   106.50 - 107.00    37.00 - 37.50      3.974    .146     78.53      4.134    .223     45.32
  2592   106.50 - 107.00    37.50 - 38.00      3.865    .155     64.05      4.176    .233     81.24
  2593   106.50 - 107.00    38.00 - 38.50      3.809    .139     53.71      4.169    .226     94.19
  2594   106.50 - 107.00    38.50 - 39.00      3.586    .180     44.80      4.164    .226     83.84
  2595   106.50 - 107.00    39.00 - 39.50      3.600    .181     27.34      4.163    .227     45.09
  2596   106.50 - 107.00    39.50 - 40.00      3.586    .180     69.64      4.094    .214     71.46
  2597   106.50 - 107.00    40.00 - 40.50      3.572    .182     79.44      4.101    .207     53.42
  2598   106.50 - 107.00    40.50 - 41.00      3.601    .221     68.19      4.097    .217     56.09
  2599   106.50 - 107.00    41.00 - 41.50      3.449    .073     78.95      4.107    .228    117.38
  3000   106.50 - 107.00    41.50 - 42.00      3.462    .004     93.16      4.107    .228    140.21
  3001   106.50 - 107.00    42.00 - 42.50      3.462    .004    107.20      4.036    .237    137.89
  3002   106.50 - 107.00    42.50 - 43.00      3.462    .004    118.87      3.569    .181     43.83
  3003   106.50 - 107.00    43.00 - 43.50      3.282    .116    101.72      3.350    .188     59.22
  3004   106.50 - 107.00    43.50 - 44.00      3.247    .082     92.36      3.314    .205     21.90
  3005   106.50 - 107.00    44.00 - 44.50      3.247    .082     73.87      3.314    .205     61.36
  3006   106.50 - 107.00    44.50 - 45.00      3.155    .010     46.65      3.273    .227     90.65
  3007   106.50 - 107.00    45.00 - 45.50      3.359    .061     90.32      3.478    .135    128.05
  3008   106.50 - 107.00    45.50 - 46.00      3.197    .031    120.05      3.472    .144    144.53
  3009   106.50 - 107.00    46.00 - 46.50      3.197    .031    152.46      3.429    .118    143.27
  3010   106.50 - 107.00    46.50 - 47.00      3.089    .076    159.99      3.201    .172    100.71
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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                                *
***********************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    B(H)    R(H)         A(N)   B(N)    R(N)   *
***********************************************************************************************
*                                                                                             *
*  3011   106.50 - 107.00   47.00 - 47.50      3.016   .149   143.54        3.146   .188    53.37  *
*  3012   106.50 - 107.00   47.50 - 48.00      3.378   .552   159.82        2.940   .316    12.20  *
*  3013   106.50 - 107.00   48.00 - 48.50      3.378   .552   134.97        2.896   .375    41.81  *
*  3014   106.50 - 107.00   48.50 - 49.00      3.378   .552   118.70        2.744   .503    69.72  *
*  3015   106.50 - 107.00   49.00 - 49.50      3.378   .552   107.12        2.744   .503   103.98  *
*  3016   106.50 - 107.00   49.50 - 50.00      3.378   .552    93.97        2.744   .503   138.36  *
*  3017   107.00 - 107.50   30.00 - 30.50      3.275   .627   144.81        3.329   .128    86.08  *
*  3018   107.00 - 107.50   30.50 - 31.00      3.463   .457   149.07        3.329   .128    97.10  *
*  3019   107.00 - 107.50   31.00 - 31.50      3.463   .457   137.87        3.329   .128   106.53  *
*  3020   107.00 - 107.50   31.50 - 32.00      4.124   .251   157.76        3.350   .130   115.55  *
*  3021   107.00 - 107.50   32.00 - 32.50      4.206   .204   135.40        3.287   .137   131.51  *
*  3022   107.00 - 107.50   32.50 - 33.00      4.234   .186   108.48        3.337   .132   143.40  *
*  3023   107.00 - 107.50   33.00 - 33.50      4.283   .208    82.06        3.136   .157   117.91  *
*  3024   107.00 - 107.50   33.50 - 34.00      4.306   .193    46.47        3.314   .172    98.10  *
*  3025   107.00 - 107.50   34.00 - 34.50      4.297   .195    13.48        3.642   .199    89.51  *
*  3026   107.00 - 107.50   34.50 - 35.00      4.300   .190    40.23        3.794   .150    91.02  *
*  3027   107.00 - 107.50   35.00 - 35.50      4.304   .186    61.19        3.812   .145    68.58  *
*  3028   107.00 - 107.50   35.50 - 36.00      4.329   .186    73.20        3.821   .139    71.13  *
*  3029   107.00 - 107.50   36.00 - 36.50      4.338   .180   100.93        3.826   .139    46.73  *
*  3030   107.00 - 107.50   36.50 - 37.00      4.341   .175   123.40        3.943   .133    16.22  *
*  3031   107.00 - 107.50   37.00 - 37.50      3.974   .146    84.55        4.168   .222    27.18  *
*  3032   107.00 - 107.50   37.50 - 38.00      3.865   .155    33.63        4.208   .232    71.30  *
*  3033   107.00 - 107.50   38.00 - 38.50      3.809   .139    23.89        4.201   .225    80.86  *
*  3034   107.00 - 107.50   38.50 - 39.00      3.586   .180    45.69        4.198   .225    80.71  *
*  3035   107.00 - 107.50   39.00 - 39.50      3.600   .181    57.72        4.195   .225    49.00  *
*  3036   107.00 - 107.50   39.50 - 40.00      3.586   .180    77.37        4.141   .207    81.67  *
*  3037   107.00 - 107.50   40.00 - 40.50      3.572   .182    75.88        4.163   .184    66.47  *
*  3038   107.00 - 107.50   40.50 - 41.00      3.601   .221    28.45        4.161   .190   101.85  *
*  3039   107.00 - 107.50   41.00 - 41.50      3.449   .073    73.73        4.172   .199   125.99  *
*  3040   107.00 - 107.50   41.50 - 42.00      3.439   .028   100.80        4.173   .197   125.96  *
*  3041   107.00 - 107.50   42.00 - 42.50      3.439   .028   109.90        4.101   .214   140.28  *
*  3042   107.00 - 107.50   42.50 - 43.00      3.439   .028   109.89        3.639   .173    88.17  *
*  3043   107.00 - 107.50   43.00 - 43.50      3.255   .089    84.51        3.526   .112    72.07  *
*  3044   107.00 - 107.50   43.50 - 44.00      3.215   .049    72.45        3.507   .112    50.47  *
*  3045   107.00 - 107.50   44.00 - 44.50      3.215   .049    58.85        3.507   .112    75.20  *
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                         * SEISMIC MAP OF CONTINENTAL U.S. *

 GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

 3046   107.00 - 107.50   44.50 - 45.00     3.104   .061     17.27      3.487   .114   105.33
 3047   107.00 - 107.50   45.00 - 45.50     3.791   .153    106.17      3.648   .153   129.74
 3048   107.00 - 107.50   45.50 - 46.00     3.791   .153    157.49      3.623   .146   141.59
 3049   107.00 - 107.50   46.00 - 46.50     3.791   .153    188.59      3.571   .129   143.66
 3050   107.00 - 107.50   46.50 - 47.00     3.687   .177    202.27      3.430   .131   119.43
 3051   107.00 - 107.50   47.00 - 47.50     3.589   .178    202.77      3.398   .129    79.20
 3052   107.00 - 107.50   47.50 - 48.00     3.430   .489    182.39      3.146   .242    37.90
 3053   107.00 - 107.50   48.00 - 48.50     3.378   .552    156.15      2.896   .375    49.69
 3054   107.00 - 107.50   48.50 - 49.00     3.378   .552    139.74      2.746   .503    73.48
 3055   107.00 - 107.50   49.00 - 49.50     3.378   .552    127.23      2.746   .503   106.54
 3056   107.00 - 107.50   49.50 - 50.00     3.378   .552    116.80      2.746   .503   140.29
 3057   107.50 - 108.00   30.00 - 30.50     3.222   .666    125.72      3.394   .126   101.01
 3058   107.50 - 108.00   30.50 - 31.00     3.430   .489    124.23      3.394   .126   119.69
 3059   107.50 - 108.00   31.00 - 31.50     3.430   .489    111.23      3.394   .126   132.16
 3060   107.50 - 108.00   31.50 - 32.00     4.148   .242    150.11      3.412   .124   143.36
 3061   107.50 - 108.00   32.00 - 32.50     4.225   .197    127.20      3.210   .207   134.32
 3062   107.50 - 108.00   32.50 - 33.00     4.252   .177     98.60      3.419   .130   159.09
 3063   107.50 - 108.00   33.00 - 33.50     4.302   .197     85.79      3.240   .198   134.40
 3064   107.50 - 108.00   33.50 - 34.00     4.306   .193     58.35      3.369   .131   119.96
 3065   107.50 - 108.00   34.00 - 34.50     4.297   .195     39.40      3.655   .197   117.15
 3066   107.50 - 108.00   34.50 - 35.00     4.300   .190     55.39      3.787   .137   110.58
 3067   107.50 - 108.00   35.00 - 35.50     4.304   .186     77.72      3.805   .133    96.28
 3068   107.50 - 108.00   35.50 - 36.00     4.329   .186     97.49      3.813   .129    82.09
 3069   107.50 - 108.00   36.00 - 36.50     4.338   .180    118.05      3.813   .129    57.17
 3070   107.50 - 108.00   36.50 - 37.00     4.341   .175    133.21      3.933   .124    42.91
 3071   107.50 - 108.00   37.00 - 37.50     3.974   .146     93.13      4.164   .219    58.77
 3072   107.50 - 108.00   37.50 - 38.00     3.865   .155     55.20      4.203   .229    53.36
 3073   107.50 - 108.00   38.00 - 38.50     3.818   .132     18.97      4.196   .222    41.88
 3074   107.50 - 108.00   38.50 - 39.00     3.600   .181     46.27      4.194   .221    55.87
 3075   107.50 - 108.00   39.00 - 39.50     3.612   .183     72.97      4.193   .220    40.84
 3076   107.50 - 108.00   39.50 - 40.00     3.600   .181     89.15      4.140   .199    85.57
 3077   107.50 - 108.00   40.00 - 40.50     3.586   .180     88.13      4.177   .175    99.85
 3078   107.50 - 108.00   40.50 - 41.00     3.616   .218     71.57      4.182   .176   116.67
 3079   107.50 - 108.00   41.00 - 41.50     3.549   .137     91.20      4.192   .186   127.43
 3080   107.50 - 108.00   41.50 - 42.00     3.687   .080    123.06      4.196   .182    65.85
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *                              *
*************************************************************************************************
*   GRID    LONG1 - LONG2       LAT1 - LAT2        A(H)    B(H)    R(H)        A(N)    B(N)    R(N)    *
*************************************************************************************************
*                                                                                               *
*   3081    107.50 - 108.00     42.00 - 42.50      3.876   .134   143.43       4.149   .200   136.53   *
*   3082    107.50 - 108.00     42.50 - 43.00      3.890   .120   133.75       3.756   .207   102.28   *
*   3083    107.50 - 108.00     43.00 - 43.50      3.843   .101   107.31       3.745   .097    83.33   *
*   3084    107.50 - 108.00     43.50 - 44.00      3.812   .132    79.84       3.735   .090    33.51   *
*   3085    107.50 - 108.00     44.00 - 44.50      3.812   .132    94.17       3.735   .090    87.58   *
*   3086    107.50 - 108.00     44.50 - 45.00      3.775   .168    78.55       3.713   .093   114.01   *
*   3087    107.50 - 108.00     45.00 - 45.50      4.265   .356   143.14       3.876   .274   127.25   *
*   3088    107.50 - 108.00     45.50 - 46.00      4.255   .359   163.89       3.834   .252   134.93   *
*   3089    107.50 - 108.00     46.00 - 46.50      4.244   .363   177.53       3.779   .223   141.32   *
*   3090    107.50 - 108.00     46.50 - 47.00      4.218   .373   191.20       3.706   .201   138.12   *
*   3091    107.50 - 108.00     47.00 - 47.50      4.203   .381   206.13       3.693   .194   123.93   *
*   3092    107.50 - 108.00     47.50 - 48.00      3.996   .297   198.38       3.317   .114    81.09   *
*   3093    107.50 - 108.00     48.00 - 48.50      3.930   .357   202.84       3.132   .202    83.97   *
*   3094    107.50 - 108.00     48.50 - 49.00      3.918   .372   205.73       3.040   .237   108.79   *
*   3095    107.50 - 108.00     49.00 - 49.50      3.430   .489   152.28       2.746   .503   113.86   *
*   3096    107.50 - 108.00     49.50 - 50.00      3.430   .489   144.94       2.746   .503   145.93   *
*   3097    108.00 - 108.50     30.00 - 30.50      3.222   .666   103.66       3.516   .224   129.66   *
*   3098    108.00 - 108.50     30.50 - 31.00      3.430   .489    94.40       3.416   .163   140.83   *
*   3099    108.00 - 108.50     31.00 - 31.50      3.430   .489    80.58       3.364   .147   148.92   *
*   3100    108.00 - 108.50     31.50 - 32.00      4.148   .242   135.92       3.402   .113   156.55   *
*   3101    108.00 - 108.50     32.00 - 32.50      4.214   .202   116.60       3.193   .185   137.04   *
*   3102    108.00 - 108.50     32.50 - 33.00      4.243   .180    51.30       3.405   .116   154.85   *
*   3103    108.00 - 108.50     33.00 - 33.50      4.294   .200    81.93       3.306   .143   137.91   *
*   3104    108.00 - 108.50     33.50 - 34.00      4.334   .222    80.59       3.369   .131   128.06   *
*   3105    108.00 - 108.50     34.00 - 34.50      4.336   .228    73.42       3.655   .197   123.47   *
*   3106    108.00 - 108.50     34.50 - 35.00      4.339   .223    81.85       3.787   .137   110.34   *
*   3107    108.00 - 108.50     35.00 - 35.50      4.343   .219    98.96       3.805   .133   109.71   *
*   3108    108.00 - 108.50     35.50 - 36.00      4.368   .215   117.85       3.813   .129    96.79   *
*   3109    108.00 - 108.50     36.00 - 36.50      4.376   .212   135.96       3.813   .129    77.65   *
*   3110    108.00 - 108.50     36.50 - 37.00      4.379   .207   148.59       3.942   .124    72.76   *
*   3111    108.00 - 108.50     37.00 - 37.50      4.082   .173   118.26       4.014   .152    72.31   *
*   3112    108.00 - 108.50     37.50 - 38.00      3.992   .196    83.71       4.044   .170    39.90   *
*   3113    108.00 - 108.50     38.00 - 38.50      3.947   .204    58.29       4.039   .166    70.40   *
*   3114    108.00 - 108.50     38.50 - 39.00      3.780   .135    70.77       4.036   .164    77.49   *
*   3115    108.00 - 108.50     39.00 - 39.50      3.663   .221    87.48       4.036   .161    73.54   *
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*********************************************************************************************************
*                                   * SEISMIC MAP OF CONTINENTAL U.S. *                                 *
*********************************************************************************************************
*   GRID      LONG1 - LONG2        LAT1 - LAT2          A(H)    C(H)     R(H)          A(N)   B(N)     R(N)    *
*********************************************************************************************************
*                                                                                                       *
*   3116     108.00 - 108.50     39.50 - 40.00         3.663   .221    103.23         3.944   .155     75.57   *
*   3117     108.00 - 108.50     40.00 - 40.50         3.697   .250    109.78         3.902   .292     65.17   *
*   3118     108.00 - 108.50     40.50 - 41.00         3.755   .297    109.78         3.931   .305     87.92   *
*   3119     108.00 - 108.50     41.00 - 41.50         3.744   .279    108.83         3.952   .316    105.47   *
*   3120     108.00 - 108.50     41.50 - 42.00         3.968   .101    130.76         3.955   .317     99.88   *
*   3121     108.00 - 108.50     42.00 - 42.50         4.011   .555    124.85         4.174   .081    139.85   *
*   3122     108.00 - 108.50     42.50 - 43.00         4.032   .558    113.47         4.095   .082    122.03   *
*   3123     108.00 - 108.50     43.00 - 43.50         4.023   .555     92.79         4.045   .092     91.43   *
*   3124     108.00 - 108.50     43.50 - 44.00         4.277   .353     54.57         4.033   .104     88.69   *
*   3125     108.00 - 108.50     44.00 - 44.50         4.277   .353    118.15         4.033   .104    109.85   *
*   3126     108.00 - 108.50     44.50 - 45.00         4.268   .355    128.97         4.023   .102    121.96   *
*   3127     108.00 - 108.50     45.00 - 45.50         4.300   .349    135.44         4.017   .196    120.26   *
*   3128     108.00 - 108.50     45.50 - 46.00         4.283   .350    143.87         3.982   .171    128.13   *
*   3129     108.00 - 108.50     46.00 - 46.50         4.274   .352    153.71         3.943   .146    138.66   *
*   3130     108.00 - 108.50     46.50 - 47.00         4.253   .356    165.54         3.907   .121    147.69   *
*   3131     108.00 - 108.50     47.00 - 47.50         4.242   .360    180.63         3.899   .119    153.56   *
*   3132     108.00 - 108.50     47.50 - 48.00         4.055   .264    180.17         3.559   .139    131.22   *
*   3133     108.00 - 108.50     48.00 - 48.50         3.983   .310    192.98         3.326   .150    125.43   *
*   3134     108.00 - 108.50     48.50 - 49.00         3.958   .339    205.65         3.166   .211    137.81   *
*   3135     108.00 - 108.50     49.00 - 49.50         3.516   .444    175.40         2.746   .503    125.12   *
*   3136     108.00 - 108.50     49.50 - 50.00         3.516   .444    173.53         2.746   .503    154.88   *
*   3137     108.50 - 109.00     30.00 - 30.50         3.222   .666     86.92         3.572   .255    160.52   *
*   3138     108.50 - 109.00     30.50 - 31.00         3.430   .489     65.76         3.288   .217    155.96   *
*   3139     108.50 - 109.00     31.00 - 31.50         3.430   .489     44.39         3.171   .243    155.48   *
*   3140     108.50 - 109.00     31.50 - 32.00         4.148   .242    113.90         3.207   .184    150.37   *
*   3141     108.50 - 109.00     32.00 - 32.50         4.214   .202    123.09         3.003   .088    116.80   *
*   3142     108.50 - 109.00     32.50 - 33.00         4.243   .180     93.35         3.257   .175    130.57   *
*   3143     108.50 - 109.00     33.00 - 33.50         4.294   .200     41.41         3.257   .175    125.29   *
*   3144     108.50 - 109.00     33.50 - 34.00         4.345   .215     94.97         3.369   .131    127.50   *
*   3145     108.50 - 109.00     34.00 - 34.50         4.362   .221    101.98         3.655   .197    120.16   *
*   3146     108.50 - 109.00     34.50 - 35.00         4.365   .216    107.39         3.787   .137     55.33   *
*   3147     108.50 - 109.00     35.00 - 35.50         4.369   .211    117.25         3.810   .133    116.93   *
*   3148     108.50 - 109.00     35.50 - 36.00         4.394   .204    128.94         3.818   .130    113.70   *
*   3149     108.50 - 109.00     36.00 - 36.50         4.399   .205    145.10         3.818   .130     99.60   *
*   3150     108.50 - 109.00     36.50 - 37.00         4.402   .200    159.80         3.951   .125     98.06   *
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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                          *
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*  GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)   Q(H)    R(H)      A(N)   Q(N)    R(N)    *
*****************************************************************************************
*                                                                                       *
*  3151   108.50 - 109.00   37.00 - 37.50      4.128   .152  138.84     3.991   .134    91.69   *
*  3152   108.50 - 109.00   37.50 - 38.00      4.075   .152  119.94     4.024   .153    81.68   *
*  3153   108.50 - 109.00   38.00 - 38.50      4.066   .152  108.76     4.018   .149    88.84   *
*  3154   108.50 - 109.00   38.50 - 39.00      3.923   .109  106.56     4.021   .151    89.72   *
*  3155   108.50 - 109.00   39.00 - 39.50      3.880   .181  117.13     4.032   .155    84.02   *
*  3156   108.50 - 109.00   39.50 - 40.00      3.801   .322  114.65     3.938   .153    69.67   *
*  3157   108.50 - 109.00   40.00 - 40.50      3.848   .357  117.42     3.909   .296    28.57   *
*  3158   108.50 - 109.00   40.50 - 41.00      3.882   .385  114.09     3.941   .312    76.88   *
*  3159   108.50 - 109.00   41.00 - 41.50      3.877   .375  101.34     3.962   .322   102.89   *
*  3160   108.50 - 109.00   41.50 - 42.00      4.154   .126  107.58     3.962   .320   108.24   *
*  3161   108.50 - 109.00   42.00 - 42.50      4.063   .569  105.71     3.979   .314   106.41   *
*  3162   108.50 - 109.00   42.50 - 43.00      4.085   .576   95.40     3.984   .316    93.69   *
*  3163   108.50 - 109.00   43.00 - 43.50      4.081   .574   72.25     3.970   .306    41.61   *
*  3164   108.50 - 109.00   43.50 - 44.00      4.310   .348   96.09     3.974   .309    85.37   *
*  3165   108.50 - 109.00   44.00 - 44.50      4.310   .348  111.47     3.969   .305    90.97   *
*  3166   108.50 - 109.00   44.50 - 45.00      4.308   .349  116.72     3.957   .294    90.51   *
*  3167   108.50 - 109.00   45.00 - 45.50      4.541   .201  141.12     4.025   .202   102.14   *
*  3168   108.50 - 109.00   45.50 - 46.00      4.529   .207  144.46     3.992   .179   111.26   *
*  3169   108.50 - 109.00   46.00 - 46.50      4.518   .213  149.69     3.954   .154   123.75   *
*  3170   108.50 - 109.00   46.50 - 47.00      4.505   .223  158.17     3.916   .131   136.71   *
*  3171   108.50 - 109.00   47.00 - 47.50      4.497   .228  170.96     3.912   .128   151.46   *
*  3172   108.50 - 109.00   47.50 - 48.00      4.353   .187  172.93     3.599   .141   146.99   *
*  3173   108.50 - 109.00   48.00 - 48.50      4.316   .223  190.86     3.382   .116   147.05   *
*  3174   108.50 - 109.00   48.50 - 49.00      4.306   .238  212.42     3.207   .184   155.99   *
*  3175   108.50 - 109.00   49.00 - 49.50      4.140   .241  227.08     2.896   .375   155.45   *
*  3176   108.50 - 109.00   49.50 - 50.00      3.430   .489  194.17     2.746   .503   166.59   *
*  3177   109.00 - 109.50   30.00 - 30.50      3.222   .666   80.45     3.725   .184   170.49   *
*  3178   109.00 - 109.50   30.50 - 31.00      3.430   .489   51.44     3.522   .167   171.90   *
*  3179   109.00 - 109.50   31.00 - 31.50      3.430   .489   14.50     3.329   .176   166.79   *
*  3180   109.00 - 109.50   31.50 - 32.00      4.148   .242   97.24     3.207   .184   139.42   *
*  3181   109.00 - 109.50   32.00 - 32.50      4.214   .202  133.86     3.003   .088    95.23   *
*  3182   109.00 - 109.50   32.50 - 33.00      4.239   .186  118.68     3.214   .194    99.44   *
*  3183   109.00 - 109.50   33.00 - 33.50      4.289   .206   98.77     3.214   .194   102.35   *
*  3184   109.00 - 109.50   33.50 - 34.00      4.356   .208  113.84     3.328   .153   116.77   *
*  3185   109.00 - 109.50   34.00 - 34.50      4.375   .211  118.54     3.642   .199   130.49   *
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *                           *
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*  GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)   C(H)    R(H)        A(N)   C(N)    R(N)  *
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*                                                                                          *
*  3186   109.00 - 109.50    34.50 - 35.00     4.379  .206   122.65       3.777  .144   121.77  *
*  3187   109.00 - 109.50    35.00 - 35.50     4.385  .197   121.62       3.808  .137   134.56  *
*  3188   109.00 - 109.50    35.50 - 36.00     4.409  .192   109.55       3.839  .136   133.31  *
*  3189   109.00 - 109.50    36.00 - 36.50     4.520  .253   149.86       3.910  .132   129.07  *
*  3190   109.00 - 109.50    36.50 - 37.00     4.522  .249   172.76       4.028  .139   125.18  *
*  3191   109.00 - 109.50    37.00 - 37.50     4.354  .243   167.75       4.060  .146   116.91  *
*  3192   109.00 - 109.50    37.50 - 38.00     4.319  .251   159.72       4.088  .162   108.46  *
*  3193   109.00 - 109.50    38.00 - 38.50     4.340  .232   156.43       4.085  .157    98.57  *
*  3194   109.00 - 109.50    38.50 - 39.00     4.303  .206   154.68       4.091  .160    92.52  *
*  3195   109.00 - 109.50    39.00 - 39.50     4.279  .143   153.00       4.102  .164    61.34  *
*  3196   109.00 - 109.50    39.50 - 40.00     4.307  .125   153.97       4.029  .144    70.25  *
*  3197   109.00 - 109.50    40.00 - 40.50     4.330  .118   151.14       4.048  .207    40.94  *
*  3198   109.00 - 109.50    40.50 - 41.00     4.344  .123   145.63       4.072  .216    85.89  *
*  3199   109.00 - 109.50    41.00 - 41.50     4.341  .114   128.32       4.064  .212   107.35  *
*  3200   109.00 - 109.50    41.50 - 42.00     4.169  .170    48.97       3.964  .321    99.86  *
*  3201   109.00 - 109.50    42.00 - 42.50     4.349  .259   117.75       3.974  .310    93.84  *
*  3202   109.00 - 109.50    42.50 - 43.00     4.351  .274   104.95       3.982  .314    88.36  *
*  3203   109.00 - 109.50    43.00 - 43.50     4.346  .272    43.55       3.971  .307    75.93  *
*  3204   109.00 - 109.50    43.50 - 44.00     4.435  .238   103.20       3.973  .308    81.33  *
*  3205   109.00 - 109.50    44.00 - 44.50     4.567  .182   121.93       3.969  .306    77.33  *
*  3206   109.00 - 109.50    44.50 - 45.00     4.561  .185   120.21       3.953  .295    68.51  *
*  3207   109.00 - 109.50    45.00 - 45.50     4.547  .198   120.44       4.079  .168    83.73  *
*  3208   109.00 - 109.50    45.50 - 46.00     4.536  .203   123.57       4.048  .146    96.97  *
*  3209   109.00 - 109.50    46.00 - 46.50     4.526  .208   127.73       4.014  .121   112.33  *
*  3210   109.00 - 109.50    46.50 - 47.00     4.524  .206   136.82       3.982  .100   128.46  *
*  3211   109.00 - 109.50    47.00 - 47.50     4.517  .211   150.18       3.979  .101   148.02  *
*  3212   109.00 - 109.50    47.50 - 48.00     4.302  .122   143.60       3.643  .140   147.42  *
*  3213   109.00 - 109.50    48.00 - 48.50     4.269  .149   162.58       3.411  .066   152.74  *
*  3214   109.00 - 109.50    48.50 - 49.00     4.259  .163   185.59       3.256  .111   164.52  *
*  3215   109.00 - 109.50    49.00 - 49.50     4.113  .222   211.78       2.972  .280   172.32  *
*  3216   109.00 - 109.50    49.50 - 50.00     3.208  .187   182.00       2.821  .411   185.86  *
*  3217   109.50 - 110.00    30.00 - 30.50     3.222  .666    87.28       3.980  .239   181.92  *
*  3218   109.50 - 110.00    30.50 - 31.00     3.430  .489    66.07       3.722  .167   178.53  *
*  3219   109.50 - 110.00    31.00 - 31.50     3.430  .489    44.61       3.552  .198   178.16  *
*  3220   109.50 - 110.00    31.50 - 32.00     4.137  .260   119.60       3.164  .211   119.96  *
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*                           * SEISMIC MAP OF CONTINENTAL U.S. *                         *
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*  GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)   C(H)    R(H)       A(N)   C(N)    R(N)   *
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*                                                                                       *
*  3221   109.50 - 110.00   32.00 - 32.50     4.143   .250   144.13     2.939   .065    64.93   *
*  3222   109.50 - 110.00   32.50 - 33.00     4.169   .236   139.35     2.854   .085    40.68   *
*  3223   109.50 - 110.00   33.00 - 33.50     4.188   .218   125.63     2.854   .085    53.44   *
*  3224   109.50 - 110.00   33.50 - 34.00     4.333   .223   120.53     3.273   .155    95.51   *
*  3225   109.50 - 110.00   34.00 - 34.50     4.347   .231   100.36     3.627   .192   128.49   *
*  3226   109.50 - 110.00   34.50 - 35.00     4.358   .226   120.29     3.766   .144   146.75   *
*  3227   109.50 - 110.00   35.00 - 35.50     4.365   .216   114.45     3.799   .134   152.10   *
*  3228   109.50 - 110.00   35.50 - 36.00     4.411   .198    47.37     3.831   .132   150.32   *
*  3229   109.50 - 110.00   36.00 - 36.50     4.511   .258   134.85     3.903   .129   147.66   *
*  3230   109.50 - 110.00   36.50 - 37.00     4.514   .254   166.64     4.009   .129   140.51   *
*  3231   109.50 - 110.00   37.00 - 37.50     4.342   .250   161.37     4.041   .134   129.20   *
*  3232   109.50 - 110.00   37.50 - 38.00     4.306   .258   156.52     4.070   .150   114.03   *
*  3233   109.50 - 110.00   38.00 - 38.50     4.363   .209   156.21     4.067   .145    65.03   *
*  3234   109.50 - 110.00   38.50 - 39.00     4.332   .174   150.16     4.074   .148    81.83   *
*  3235   109.50 - 110.00   39.00 - 39.50     4.352   .157   148.32     4.090   .155    60.87   *
*  3236   109.50 - 110.00   39.50 - 40.00     4.375   .146   143.76     4.014   .133    53.98   *
*  3237   109.50 - 110.00   40.00 - 40.50     4.389   .138   136.28     4.031   .197    52.22   *
*  3238   109.50 - 110.00   40.50 - 41.00     4.402   .141   130.22     4.056   .207    86.94   *
*  3239   109.50 - 110.00   41.00 - 41.50     4.380   .138   121.77     4.050   .203    99.39   *
*  3240   109.50 - 110.00   41.50 - 42.00     4.155   .160    86.94     3.946   .311    84.42   *
*  3241   109.50 - 110.00   42.00 - 42.50     4.405   .227   115.14     4.043   .216    75.79   *
*  3242   109.50 - 110.00   42.50 - 43.00     4.408   .238   105.83     4.058   .226    81.87   *
*  3243   109.50 - 110.00   43.00 - 43.50     4.404   .237    87.04     4.048   .219    80.16   *
*  3244   109.50 - 110.00   43.50 - 44.00     4.483   .209    98.41     4.052   .221    75.52   *
*  3245   109.50 - 110.00   44.00 - 44.50     4.596   .177   103.53     4.049   .219    66.04   *
*  3246   109.50 - 110.00   44.50 - 45.00     4.567   .182    95.62     4.035   .208    41.71   *
*  3247   109.50 - 110.00   45.00 - 45.50     4.556   .195    98.5[illegible]     4.081   .172    54.31   *
*  3248   109.50 - 110.00   45.50 - 46.00     4.546   .199   103.09     4.059   .156    77.20   *
*  3249   109.50 - 110.00   46.00 - 46.50     4.536   .203   105.66     4.027   .131    96.35   *
*  3250   109.50 - 110.00   46.50 - 47.00     4.535   .199   114.68     4.006   .119   115.34   *
*  3251   109.50 - 110.00   47.00 - 47.50     4.529   .203   129.25     4.003   .119   136.38   *
*  3252   109.50 - 110.00   47.50 - 48.00     4.319   .120   126.17     3.706   .176   139.93   *
*  3253   109.50 - 110.00   48.00 - 48.50     4.281   .141   146.00     3.518   .107   150.21   *
*  3254   109.50 - 110.00   48.50 - 49.00     4.272   .155   170.09     3.416   .089   165.45   *
*  3255   109.50 - 110.00   49.00 - 49.50     4.136   .208   195.39     3.271   .152   184.34   *
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                         * SEISMIC MAP OF CONTINENTAL U.S. *

  GFID     LONG1 - LONG2      LAT1 - LAT2       A(H)    C(H)    R(H)       A(N)   P(N)    R(N)

  3256    109.50 - 110.00    49.50 - 50.00     3.259   .117   164.32      3.190   .210   206.58
  3257    110.00 - 110.50    30.00 - 30.50     3.222   .666   104.79      4.119   .241   162.30
  3258    110.00 - 110.50    30.50 - 31.00     3.430   .489    96.12      3.941   .211   160.85
  3259    110.00 - 110.50    31.00 - 31.50     3.430   .489    83.13      3.850   .228   166.07
  3260    110.00 - 110.50    31.50 - 32.00     3.594   .383   105.31      3.604   .252   134.66
  3261    110.00 - 110.50    32.00 - 32.50     3.615   .358   119.78      3.639   .245    97.56
  3262    110.00 - 110.50    32.50 - 33.00     3.702   .319   125.74      3.561   .256    28.67
  3263    110.00 - 110.50    33.00 - 33.50     3.762   .270   112.52      3.273   .155    56.07
  3264    110.00 - 110.50    33.50 - 34.00     4.241   .239   108.22      3.337   .132    79.38
  3265    110.00 - 110.50    34.00 - 34.50     4.232   .248    36.67      3.611   .177    92.35
  3266    110.00 - 110.50    34.50 - 35.00     4.260   .233   103.84      3.718   .143   135.30
  3267    110.00 - 110.50    35.00 - 35.50     4.281   .214   115.46      3.775   .131   162.93
  3268    110.00 - 110.50    35.50 - 36.00     4.343   .196   101.19      3.804   .125   164.96
  3269    110.00 - 110.50    36.00 - 36.50     4.461   .260   129.28      3.880   .126   161.17
  3270    110.00 - 110.50    36.50 - 37.00     4.461   .260   146.99      3.981   .118   148.39
  3271    110.00 - 110.50    37.00 - 37.50     4.270   .244   137.67      4.019   .123   133.23
  3272    110.00 - 110.50    37.50 - 38.00     4.291   .225   139.64      4.045   .136   116.55
  3273    110.00 - 110.50    38.00 - 38.50     4.347   .178   138.14      4.059   .140    96.05
  3274    110.00 - 110.50    38.50 - 39.00     4.358   .170   135.60      4.067   .143    72.55
  3275    110.00 - 110.50    39.00 - 39.50     4.375   .156   132.77      4.083   .150    27.63
  3276    110.00 - 110.50    39.50 - 40.00     4.418   .142   128.15      4.008   .128    24.10
  3277    110.00 - 110.50    40.00 - 40.50     4.423   .135   115.53      4.024   .192    61.86
  3278    110.00 - 110.50    40.50 - 41.00     4.428   .139   103.46      4.038   .198    83.91
  3279    110.00 - 110.50    41.00 - 41.50     4.401   .137   106.93      4.020   .189    87.75
  3280    110.00 - 110.50    41.50 - 42.00     4.184   .165    85.36      3.912   .295    64.91
  3281    110.00 - 110.50    42.00 - 42.50     4.422   .218   102.33      4.030   .206    36.51
  3282    110.00 - 110.50    42.50 - 43.00     4.431   .226    96.02      4.048   .217    61.66
  3283    110.00 - 110.50    43.00 - 43.50     4.426   .225    86.51      4.036   .212    62.30
  3284    110.00 - 110.50    43.50 - 44.00     4.504   .195    77.72      4.045   .217    52.22
  3285    110.00 - 110.50    44.00 - 44.50     4.614   .167    78.51      4.044   .216    45.85
  3286    110.00 - 110.50    44.50 - 45.00     4.587   .170    65.22      4.034   .213    29.73
  3287    110.00 - 110.50    45.00 - 45.50     4.564   .194    75.24      4.083   .174    52.06
  3288    110.00 - 110.50    45.50 - 46.00     4.564   .185    83.89      4.065   .161    48.44
  3289    110.00 - 110.50    46.00 - 46.50     4.555   .189    82.60      4.033   .137    81.67
  3290    110.00 - 110.50    46.50 - 47.00     4.553   .186    93.09      4.014   .125   101.99
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                          * SEISMIC MAP OF CONTINENTAL U.S. *

  GRID    LONG1 - LONG2    LAT1 - LAT2      A(H)    B(H)    R(H)       A(N)   B(N)    R(N)

  3291   110.00 - 110.50   47.00 - 47.50    4.548   .190   109.25      4.019  .125   125.06
  3292   110.00 - 110.50   47.50 - 48.00    4.346   .117   110.53      3.725  .186   129.22
  3293   110.00 - 110.50   48.00 - 48.50    4.312   .135   132.25      3.551  .114   139.22
  3294   110.00 - 110.50   48.50 - 49.00    4.304   .147   156.94      3.460  .085   152.65
  3295   110.00 - 110.50   49.00 - 49.50    4.191   .192   182.09      3.338  .116   168.21
  3296   110.00 - 110.50   49.50 - 50.00    3.581   .181   173.22      3.282  .133   188.54
  3297   110.50 - 111.00   30.00 - 30.50    3.222   .666   128.35      4.231  .204   140.74
  3298   110.50 - 111.00   30.50 - 31.00    3.430   .489   129.26      4.080  .215   137.37
  3299   110.50 - 111.00   31.00 - 31.50    3.430   .489   119.35      4.024  .207   144.24
  3300   110.50 - 111.00   31.50 - 32.00    3.594   .383   136.72      3.836  .304   129.24
  3301   110.50 - 111.00   32.00 - 32.50    3.615   .358   140.81      3.836  .304   116.94
  3302   110.50 - 111.00   32.50 - 33.00    3.702   .319   141.07      3.738  .256    82.38
  3303   110.50 - 111.00   33.00 - 33.50    3.762   .270   123.82      3.564  .136    35.32
  3304   110.50 - 111.00   33.50 - 34.00    3.934   .256   104.16      4.021  .184   122.78
  3305   110.50 - 111.00   34.00 - 34.50    3.828   .172    66.55      3.667  .168    37.20
  3306   110.50 - 111.00   34.50 - 35.00    3.931   .149    87.17      3.352  .119    86.85
  3307   110.50 - 111.00   35.00 - 35.50    3.968   .122    88.34      3.370  .136   132.22
  3308   110.50 - 111.00   35.50 - 36.00    4.050   .147    81.82      3.485  .110   156.69
  3309   110.50 - 111.00   36.00 - 36.50    4.285   .233    83.71      3.573  .141   147.93
  3310   110.50 - 111.00   36.50 - 37.00    4.285   .233   104.78      3.787  .115   139.21
  3311   110.50 - 111.00   37.00 - 37.50    4.280   .241   120.50      3.857  .133   119.95
  3312   110.50 - 111.00   37.50 - 38.00    4.302   .221   122.84      3.909  .149   103.21
  3313   110.50 - 111.00   38.00 - 38.50    4.355   .175   118.87      3.928  .153    87.01
  3314   110.50 - 111.00   38.50 - 39.00    4.364   .171   114.31      3.940  .158    65.45
  3315   110.50 - 111.00   39.00 - 39.50    4.382   .154   113.91      3.980  .175    38.58
  3316   110.50 - 111.00   39.50 - 40.00    4.424   .140   107.94      3.991  .179    38.50
  3317   110.50 - 111.00   40.00 - 40.50    4.414   .139    87.76      4.029  .195    50.94
  3318   110.50 - 111.00   40.50 - 41.00    4.418   .142    56.01      4.044  .200    73.74
  3319   110.50 - 111.00   41.00 - 41.50    4.398   .140    86.90      4.026  .190    77.58
  3320   110.50 - 111.00   41.50 - 42.00    4.182   .165    65.13      3.920  .297    36.58
  3321   110.50 - 111.00   42.00 - 42.50    4.419   .220    79.96      4.037  .211    56.69
  3322   110.50 - 111.00   42.50 - 43.00    4.428   .227    72.48      4.054  .222    33.89
  3323   110.50 - 111.00   43.00 - 43.50    4.424   .226    67.57      4.047  .217    35.10
  3324   110.50 - 111.00   43.50 - 44.00    4.502   .196    40.58      4.052  .222    56.31
  3325   110.50 - 111.00   44.00 - 44.50    4.613   .160    47.10      4.052  .221    38.08
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• SEISMIC MAP OF CONTINENTAL U.S. •

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
3226	110.50 - 111.00	44.50 - 45.00	4.593	.171	30.41	4.036	.213	22.57
3227	110.50 - 111.00	45.00 - 45.50	4.567	.191	48.73	4.149	.301	34.12
3228	110.50 - 111.00	45.50 - 46.00	4.584	.170	65.92	4.143	.297	59.58
3229	110.50 - 111.00	46.00 - 46.50	4.575	.173	53.32	4.123	.282	67.90
3230	110.50 - 111.00	46.50 - 47.00	4.573	.172	72.41	4.115	.276	91.18
3231	110.50 - 111.00	47.00 - 47.50	4.567	.175	87.24	4.103	.269	111.27
3232	110.50 - 111.00	47.50 - 48.00	4.375	.114	95.81	4.160	.120	146.24
3233	110.50 - 111.00	48.00 - 48.50	4.344	.126	119.97	4.066	.141	152.98
3234	110.50 - 111.00	48.50 - 49.00	4.337	.137	144.16	4.028	.144	164.81
3235	110.50 - 111.00	49.00 - 49.50	4.247	.168	167.34	3.988	.155	180.95
3236	110.50 - 111.00	49.50 - 50.00	3.792	.161	164.94	3.972	.159	201.77
3237	111.00 - 111.50	30.00 - 30.50	3.067	.849	137.04	4.387	.313	112.92
3238	111.00 - 111.50	30.50 - 31.00	3.378	.552	158.65	4.325	.297	114.30
3239	111.00 - 111.50	31.00 - 31.50	3.378	.552	150.52	4.307	.287	120.74
3240	111.00 - 111.50	31.50 - 32.00	3.565	.420	166.96	4.257	.283	125.01
3241	111.00 - 111.50	32.00 - 32.50	3.594	.383	164.43	4.252	.280	132.49
3242	111.00 - 111.50	32.50 - 33.00	3.686	.338	158.24	4.216	.256	137.79
3243	111.00 - 111.50	33.00 - 33.50	3.750	.283	138.99	4.071	.264	121.22
3244	111.00 - 111.50	33.50 - 34.00	3.962	.234	130.41	4.425	.339	170.18
3245	111.00 - 111.50	34.00 - 34.50	3.862	.157	97.18	3.784	.279	105.23
3246	111.00 - 111.50	34.50 - 35.00	3.963	.132	86.84	3.953	.159	157.61
3247	111.00 - 111.50	35.00 - 35.50	3.995	.113	67.61	3.956	.150	175.61
3248	111.00 - 111.50	35.50 - 36.00	4.027	.125	63.32	3.959	.146	169.41
3249	111.00 - 111.50	36.00 - 36.50	4.265	.239	33.06	4.007	.155	157.49
3250	111.00 - 111.50	36.50 - 37.00	4.265	.239	78.56	4.052	.148	137.72
3251	111.00 - 111.50	37.00 - 37.50	4.260	.247	100.04	4.083	.157	117.62
3252	111.00 - 111.50	37.50 - 38.00	4.287	.217	101.82	4.105	.172	96.89
3253	111.00 - 111.50	38.00 - 38.50	4.343	.170	93.44	4.113	.177	89.27
3254	111.00 - 111.50	38.50 - 39.00	4.351	.167	85.24	4.120	.179	73.75
3255	111.00 - 111.50	39.00 - 39.50	4.370	.150	91.47	4.136	.190	38.44
3256	111.00 - 111.50	39.50 - 40.00	4.415	.134	87.88	4.143	.192	43.07
3257	111.00 - 111.50	40.00 - 40.50	4.401	.136	49.79	3.918	.297	41.72
3258	111.00 - 111.50	40.50 - 41.00	4.406	.139	57.51	3.937	.307	38.00
3259	111.00 - 111.50	41.00 - 41.50	4.403	.133	70.71	3.924	.300	59.21
3260	111.00 - 111.50	41.50 - 42.00	4.187	.165	34.21	4.081	.091	63.88

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*                                  * SEISMIC MAP OF CONTINENTAL U.S. *                              *
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*   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    B(H)    R(H)        A(N)    B(N)    R(N)    *
*****************************************************************************************************
*                                                                                                   *
*   3261   111.00 - 111.50    42.00 - 42.50       4.422   .218    49.21       4.043   .214    42.92   *
*   3262   111.00 - 111.50    42.50 - 43.00       4.431   .226    37.49       4.060   .225    27.64   *
*   3263   111.00 - 111.50    43.00 - 43.50       4.425   .225    37.93       4.057   .220    25.68   *
*   3264   111.00 - 111.50    43.50 - 44.00       4.504   .195    44.30       4.056   .225    46.99   *
*   3265   111.00 - 111.50    44.00 - 44.50       4.614   .167    52.60       4.058   .225    44.06   *
*   3266   111.00 - 111.50    44.50 - 45.00       4.595   .169    27.15       4.044   .219    16.79   *
*   3267   111.00 - 111.50    45.00 - 45.50       4.577   .179    34.41       4.175   .321    35.64   *
*   3268   111.00 - 111.50    45.50 - 46.00       4.584   .170    47.78       4.171   .317    45.06   *
*   3269   111.00 - 111.50    46.00 - 46.50       4.575   .173    23.19       4.157   .303    37.57   *
*   3270   111.00 - 111.50    46.50 - 47.00       4.573   .172    56.13       4.145   .298    81.38   *
*   3271   111.00 - 111.50    47.00 - 47.50       4.566   .177    55.21       4.307   .240   119.25   *
*   3272   111.00 - 111.50    47.50 - 48.00       4.375   .114    82.24       4.305   .133   139.97   *
*   3273   111.00 - 111.50    48.00 - 48.50       4.344   .126   109.26       4.252   .161   145.56   *
*   3274   111.00 - 111.50    48.50 - 49.00       4.337   .137   132.91       4.232   .169   152.70   *
*   3275   111.00 - 111.50    49.00 - 49.50       4.247   .168   151.55       4.211   .182   160.91   *
*   3276   111.00 - 111.50    49.50 - 50.00       3.792   .161   144.43       4.203   .189   170.93   *
*   3277   111.50 - 112.00    30.00 - 30.50       3.386   .546   210.14       4.720   .335   110.96   *
*   3278   111.50 - 112.00    30.50 - 31.00       3.386   .546   194.09       4.694   .323   113.10   *
*   3279   111.50 - 112.00    31.00 - 31.50       3.386   .546   185.96       4.689   .321   118.99   *
*   3280   111.50 - 112.00    31.50 - 32.00       3.571   .416   197.20       4.674   .314   127.23   *
*   3281   111.50 - 112.00    32.00 - 32.50       3.598   .379   187.26       4.662   .310   139.11   *
*   3282   111.50 - 112.00    32.50 - 33.00       3.690   .335   175.56       4.548   .387   142.86   *
*   3283   111.50 - 112.00    33.00 - 33.50       3.753   .282   154.81       4.486   .362   156.80   *
*   3284   111.50 - 112.00    33.50 - 34.00       4.360   .407   195.56       4.449   .348   172.07   *
*   3285   111.50 - 112.00    34.00 - 34.50       4.335   .374   152.27       3.841   .302   138.15   *
*   3286   111.50 - 112.00    34.50 - 35.00       4.381   .334   107.52       3.991   .171   167.22   *
*   3287   111.50 - 112.00    35.00 - 35.50       4.239   .203    36.22       3.974   .158   166.06   *
*   3288   111.50 - 112.00    35.50 - 36.00       4.261   .191    48.80       3.970   .147   153.21   *
*   3289   111.50 - 112.00    36.00 - 36.50       4.317   .199    68.51       4.017   .155   139.87   *
*   3290   111.50 - 112.00    36.50 - 37.00       4.317   .199    44.68       4.062   .150   122.43   *
*   3291   111.50 - 112.00    37.00 - 37.50       4.313   .205    87.96       4.092   .160   101.22   *
*   3292   111.50 - 112.00    37.50 - 38.00       4.335   .184    83.55       4.117   .175    54.04   *
*   3293   111.50 - 112.00    38.00 - 38.50       4.380   .151    70.72       4.121   .180    68.86   *
*   3294   111.50 - 112.00    38.50 - 39.00       4.378   .151    51.36       4.123   .181    58.82   *
*   3295   111.50 - 112.00    39.00 - 39.50       4.370   .150    70.26       4.137   .187    43.46   *
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                          * SEISMIC MAP OF CONTINENTAL U.S. *

   GRID     LONG1  - LONG2       LAT1 - LAT2         A(H)    C(H)    R(H)         A(N)    C(N)    R(N)

   3396    111.50 - 112.00     39.50 - 40.00        4.415   .134    73.40        4.140   .189    56.50
   3397    111.50 - 112.00     40.00 - 40.50        4.414   .134    36.48        3.912   .292    64.16
   3398    111.50 - 112.00     40.50 - 41.00        4.420   .137    25.67        3.938   .307    60.74
   3399    111.50 - 112.00     41.00 - 41.50        4.414   .134    57.82        3.927   .301    32.55
   3400    111.50 - 112.00     41.50 - 42.00        4.207   .167    46.79        4.155   .107    39.79
   3401    111.50 - 112.00     42.00 - 42.50        4.433   .211    39.77        4.078   .242    63.33
   3402    111.50 - 112.00     42.50 - 43.00        4.443   .216    37.66        4.094   .253    36.96
   3403    111.50 - 112.00     43.00 - 43.50        4.437   .215    67.14        4.088   .248    36.67
   3404    111.50 - 112.00     43.50 - 44.00        4.514   .185    76.13        4.092   .253    60.22
   3405    111.50 - 112.00     44.00 - 44.50        4.622   .159    72.77        4.095   .252    49.35
   3406    111.50 - 112.00     44.50 - 45.00        4.603   .160    41.94        4.079   .247    21.19
   3407    111.50 - 112.00     45.00 - 45.50        4.596   .157    40.30        4.176   .322    26.89
   3408    111.50 - 112.00     45.50 - 46.00        4.602   .152    44.41        4.171   .318    38.10
   3409    111.50 - 112.00     46.00 - 46.50        4.594   .155    40.86        4.153   .304    42.42
   3410    111.50 - 112.00     46.50 - 47.00        4.590   .157    39.85        4.151   .302    74.19
   3411    111.50 - 112.00     47.00 - 47.50        4.584   .162    44.47        4.309   .240   106.27
   3412    111.50 - 112.00     47.50 - 48.00        4.376   .112    74.50        4.305   .133   121.72
   3413    111.50 - 112.00     48.00 - 48.50        4.346   .123   101.55        4.252   .161   125.75
   3414    111.50 - 112.00     48.50 - 49.00        4.339   .133   121.81        4.232   .169   133.34
   3415    111.50 - 112.00     49.00 - 49.50        4.251   .162   130.88        4.211   .182   141.61
   3416    111.50 - 112.00     49.50 - 50.00        3.806   .143   122.92        4.203   .189   151.18
   3417    112.00 - 112.50     30.00 - 30.50        3.633   .743   302.85        4.772   .286    86.30
   3418    112.00 - 112.50     30.50 - 31.00        3.911   .746   302.02        4.711   .328    85.25
   3419    112.00 - 112.50     31.00 - 31.50        3.911   .746   269.06        4.703   .325    94.33
   3420    112.00 - 112.50     31.50 - 32.00        4.008   .652   251.98        4.688   .319   102.20
   3421    112.00 - 112.50     32.00 - 32.50        4.029   .623   230.38        4.677   .315   117.17
   3422    112.00 - 112.50     32.50 - 33.00        4.087   .573   217.34        4.564   .393   125.46
   3423    112.00 - 112.50     33.00 - 33.50        4.172   .482   209.03        4.507   .369   143.53
   3424    112.00 - 112.50     33.50 - 34.00        4.481   .362   210.56        4.464   .353   160.99
   3425    112.00 - 112.50     34.00 - 34.50        4.459   .334   160.26        3.893   .323   125.63
   3426    112.00 - 112.50     34.50 - 35.00        4.493   .300    67.14        4.024   .182   158.77
   3427    112.00 - 112.50     35.00 - 35.50        4.339   .189    90.39        4.016   .176   155.60
   3428    112.00 - 112.50     35.50 - 36.00        4.358   .175    89.66        4.006   .167   138.40
   3429    112.00 - 112.50     36.00 - 36.50        4.346   .180    42.63        4.050   .170   123.15
   3430    112.00 - 112.50     36.50 - 37.00        4.346   .180    78.74        4.091   .169   107.35
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* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	O(H)	R(H)	A(N)	B(N)	R(N)
3431	112.00 - 112.50	37.00 - 37.50	4.343	.185	75.79	4.118	.179	91.11
3432	112.00 - 112.50	37.50 - 38.00	4.362	.168	50.63	4.128	.185	52.24
3433	112.00 - 112.50	38.00 - 38.50	4.402	.143	53.65	4.135	.190	36.27
3434	112.00 - 112.50	38.50 - 39.00	4.401	.139	19.42	4.138	.191	27.19
3435	112.00 - 112.50	39.00 - 39.50	4.370	.150	58.82	4.147	.197	37.32
3436	112.00 - 112.50	39.50 - 40.00	4.415	.134	46.72	4.153	.199	80.02
3437	112.00 - 112.50	40.00 - 40.50	4.414	.134	47.48	3.919	.294	75.83
3438	112.00 - 112.50	40.50 - 41.00	4.420	.137	35.85	3.905	.291	42.30
3439	112.00 - 112.50	41.00 - 41.50	4.414	.134	35.90	3.891	.285	46.35
3440	112.00 - 112.50	41.50 - 42.00	4.207	.167	27.13	4.121	.141	58.49
3441	112.00 - 112.50	42.00 - 42.50	4.453	.203	32.67	4.066	.238	76.33
3442	112.00 - 112.50	42.50 - 43.00	4.464	.203	67.21	4.084	.248	67.82
3443	112.00 - 112.50	43.00 - 43.50	4.459	.203	85.77	4.087	.251	65.81
3444	112.00 - 112.50	43.50 - 44.00	4.533	.171	95.66	4.092	.256	69.33
3445	112.00 - 112.50	44.00 - 44.50	4.636	.147	87.25	4.091	.255	56.98
3446	112.00 - 112.50	44.50 - 45.00	4.620	.144	42.93	4.078	.251	40.18
3447	112.00 - 112.50	45.00 - 45.50	4.595	.158	66.48	4.176	.322	39.91
3448	112.00 - 112.50	45.50 - 46.00	4.601	.154	64.96	4.172	.318	43.09
3449	112.00 - 112.50	46.00 - 46.50	4.593	.157	43.01	4.154	.304	61.93
3450	112.00 - 112.50	46.50 - 47.00	4.590	.157	17.21	4.152	.303	52.16
3451	112.00 - 112.50	47.00 - 47.50	4.584	.162	53.30	4.309	.240	89.87
3452	112.00 - 112.50	47.50 - 48.00	4.376	.112	72.49	4.305	.133	101.89
3453	112.00 - 112.50	48.00 - 48.50	4.346	.123	95.19	4.252	.161	104.65
3454	112.00 - 112.50	48.50 - 49.00	4.339	.133	109.71	4.232	.169	114.19
3455	112.00 - 112.50	49.00 - 49.50	4.251	.162	93.23	4.211	.182	122.88
3456	112.00 - 112.50	49.50 - 50.00	3.806	.143	100.05	4.203	.189	131.31
3457	112.50 - 113.00	30.00 - 30.50	3.863	.667	300.77	4.780	.287	42.63
3458	112.50 - 113.00	30.50 - 31.00	4.166	.640	291.85	4.720	.330	48.07
3459	112.50 - 113.00	31.00 - 31.50	4.166	.640	254.68	4.712	.328	70.96
3460	112.50 - 113.00	31.50 - 32.00	4.214	.586	230.20	4.697	.321	68.46
3461	112.50 - 113.00	32.00 - 32.50	4.229	.562	209.79	4.686	.317	95.46
3462	112.50 - 113.00	32.50 - 33.00	4.263	.528	200.93	4.575	.397	106.25
3463	112.50 - 113.00	33.00 - 33.50	4.307	.469	201.94	4.520	.373	128.50
3464	112.50 - 113.00	33.50 - 34.00	4.786	.370	223.79	4.533	.379	146.23
3465	112.50 - 113.00	34.00 - 34.50	4.791	.367	209.25	4.182	.317	78.77

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                              * SEISMIC MAP OF CONTINENTAL U.S. *

 GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)   C(H)    R(H)        A(N)   C(N)    R(N)

 3466   112.50 - 113.00   34.50 - 35.00     4.801   .353   179.09      4.240   .246   153.71
 3467   112.50 - 113.00   35.00 - 35.50     4.701   .276   163.99      4.214   .242   151.65
 3468   112.50 - 113.00   35.50 - 36.00     4.568   .242   133.69      4.170   .213   132.78
 3469   112.50 - 113.00   36.00 - 36.50     4.354   .177    88.99      4.154   .202   111.69
 3470   112.50 - 113.00   36.50 - 37.00     4.356   .178    83.02      4.178   .196    94.31
 3471   112.50 - 113.00   37.00 - 37.50     4.343   .185    40.32      4.195   .198    80.88
 3472   112.50 - 113.00   37.50 - 38.00     4.362   .168    60.32      4.200   .198    74.03
 3473   112.50 - 113.00   38.00 - 38.50     4.423   .133    30.58      4.206   .201    71.55
 3474   112.50 - 113.00   38.50 - 39.00     4.420   .132    49.89      4.208   .202    66.79
 3475   112.50 - 113.00   39.00 - 39.50     4.388   .150    70.55      4.216   .207    78.02
 3476   112.50 - 113.00   39.50 - 40.00     4.430   .134    81.55      4.204   .200   100.71
 3477   112.50 - 113.00   40.00 - 40.50     4.430   .134    73.38      3.914   .292    88.44
 3478   112.50 - 113.00   40.50 - 41.00     4.428   .138    37.04      3.893   .289    78.10
 3479   112.50 - 113.00   41.00 - 41.50     4.422   .136    61.39      3.878   .285    75.50
 3480   112.50 - 113.00   41.50 - 42.00     4.221   .167    28.80      4.102   .163    93.19
 3481   112.50 - 113.00   42.00 - 42.50     4.459   .201    58.57      4.059   .236    90.66
 3482   112.50 - 113.00   42.50 - 43.00     4.471   .198    81.97      4.078   .245    87.21
 3483   112.50 - 113.00   43.00 - 43.50     4.466   .198    99.71      4.089   .252    82.71
 3484   112.50 - 113.00   43.50 - 44.00     4.528   .173   108.85      4.093   .256    76.77
 3485   112.50 - 113.00   44.00 - 44.50     4.632   .149   103.12      4.092   .256    62.79
 3486   112.50 - 113.00   44.50 - 45.00     4.617   .145    80.94      4.079   .252    29.11
 3487   112.50 - 113.00   45.00 - 45.50     4.613   .146    78.93      4.172   .319    34.90
 3488   112.50 - 113.00   45.50 - 46.00     4.618   .142    75.89      4.167   .315    62.21
 3489   112.50 - 113.00   46.00 - 46.50     4.611   .144    40.81      4.155   .305    49.55
 3490   112.50 - 113.00   46.50 - 47.00     4.599   .149    37.52      4.152   .303    54.65
 3491   112.50 - 113.00   47.00 - 47.50     4.591   .155    61.48      4.309   .240    61.89
 3492   112.50 - 113.00   47.50 - 48.00     4.385   .111    69.75      4.305   .133    80.90
 3493   112.50 - 113.00   48.00 - 48.50     4.357   .117    88.04      4.252   .161    79.37
 3494   112.50 - 113.00   48.50 - 49.00     4.350   .126    99.93      4.232   .169    95.72
 3495   112.50 - 113.00   49.00 - 49.50     4.269   .149    45.05      4.211   .182   104.61
 3496   112.50 - 113.00   49.50 - 50.00     3.862   .125    91.73      4.203   .189   110.70
 3497   113.00 - 113.50   31.00 - 31.50     4.677   .496   241.07      4.752   .341    45.18
 3498   113.00 - 113.50   31.50 - 32.00     4.687   .484   213.19      4.740   .336    48.57
 3499   113.00 - 113.50   32.00 - 32.50     4.691   .476   192.37      4.731   .332    77.46
 3500   113.00 - 113.50   32.50 - 33.00     4.702   .465   183.52      4.628   .418    75.11
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*                                 * SEISMIC MAP OF CONTINENTAL U.S. *                               *
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*   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)          A(N)    C(N)    R(N)   *
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*                                                                                                   *
*   3501    113.00 - 113.50    33.00 - 33.50      4.718   .441   188.54        4.578   .396   115.40   *
*   3502    113.00 - 113.50    33.50 - 34.00      4.825   .332   202.38        4.667   .258   142.27   *
*   3503    113.00 - 113.50    34.00 - 34.50      4.829   .330   207.76        4.420   .202   141.79   *
*   3504    113.00 - 113.50    34.50 - 35.00      4.837   .321   204.10        4.990   .241   207.69   *
*   3505    113.00 - 113.50    35.00 - 35.50      4.735   .251   179.06        4.986   .240   195.80   *
*   3506    113.00 - 113.50    35.50 - 36.00      4.617   .217   149.28        4.971   .250   175.92   *
*   3507    113.00 - 113.50    36.00 - 36.50      4.380   .173   105.05        4.910   .269   145.82   *
*   3508    113.00 - 113.50    36.50 - 37.00      4.372   .167    83.66        4.913   .263   124.88   *
*   3509    113.00 - 113.50    37.00 - 37.50      4.352   .187    39.39        4.915   .259    92.74   *
*   3510    113.00 - 113.50    37.50 - 38.00      4.353   .170    39.21        4.916   .257    87.89   *
*   3511    113.00 - 113.50    38.00 - 38.50      4.415   .133    40.87        4.919   .255   133.24   *
*   3512    113.00 - 113.50    38.50 - 39.00      4.420   .132    74.49        4.920   .255   148.01   *
*   3513    113.00 - 113.50    39.00 - 39.50      4.388   .150    89.72        4.922   .253   164.05   *
*   3514    113.00 - 113.50    39.50 - 40.00      4.430   .134   100.04        4.917   .255   185.06   *
*   3515    113.00 - 113.50    40.00 - 40.50      4.430   .134    92.19        4.033   .192   113.47   *
*   3516    113.00 - 113.50    40.50 - 41.00      4.428   .138    77.31        4.016   .184   110.59   *
*   3517    113.00 - 113.50    41.00 - 41.50      4.442   .136    82.93        4.009   .179   101.71   *
*   3518    113.00 - 113.50    41.50 - 42.00      4.247   .181    57.37        4.123   .142    97.78   *
*   3519    113.00 - 113.50    42.00 - 42.50      4.474   .199    37.42        4.067   .239   100.16   *
*   3520    113.00 - 113.50    42.50 - 43.00      4.485   .196    89.89        4.085   .248    98.91   *
*   3521    113.00 - 113.50    43.00 - 43.50      4.480   .196   109.54        4.094   .255    90.21   *
*   3522    113.00 - 113.50    43.50 - 44.00      4.542   .165   118.48        4.092   .256    78.43   *
*   3523    113.00 - 113.50    44.00 - 44.50      4.644   .141   110.22        4.091   .255    67.24   *
*   3524    113.00 - 113.50    44.50 - 45.00      4.628   .137   101.22        4.078   .251    54.85   *
*   3525    113.00 - 113.50    45.00 - 45.50      4.610   .146    53.48        4.172   .319    46.74   *
*   3526    113.00 - 113.50    45.50 - 46.00      4.622   .138    86.75        4.167   .315    73.00   *
*   3527    113.00 - 113.50    46.00 - 46.50      4.618   .139    69.55        4.155   .305    73.18   *
*   3528    113.00 - 113.50    46.50 - 47.00      4.605   .145    45.93        4.152   .303    50.14   *
*   3529    113.00 - 113.50    47.00 - 47.50      4.598   .151    65.55        4.309   .240    41.72   *
*   3530    113.00 - 113.50    47.50 - 48.00      4.396   .111    50.55        4.305   .133    59.86   *
*   3531    113.00 - 113.50    48.00 - 48.50      4.368   .118    73.13        4.252   .161    46.27   *
*   3532    113.00 - 113.50    48.50 - 49.00      4.362   .127    95.11        4.232   .169    80.51   *
*   3533    113.00 - 113.50    49.00 - 49.50      4.288   .145    91.87        4.211   .182    85.16   *
*   3534    113.00 - 113.50    49.50 - 50.00      3.915   .135   103.62        4.203   .189    88.45   *
*   3535    113.50 - 114.00    31.00 - 31.50      4.734   .431   214.38        4.790   .303    25.21   *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)    D(H)     R(H)       A(N)    D(N)     R(N)

3536   113.50 - 114.00   31.50 - 32.00    4.747   .411   180.68      4.783   .299     36.14
3537   113.50 - 114.00   32.00 - 32.50    4.756   .403   155.12      4.777   .295     50.64
3538   113.50 - 114.00   32.50 - 33.00    4.764   .396   140.02      4.729   .290     89.15
3539   113.50 - 114.00   33.00 - 33.50    4.775   .380   151.07      4.697   .271    111.82
3540   113.50 - 114.00   33.50 - 34.00    4.942   .332   184.84      4.731   .273    132.33
3541   113.50 - 114.00   34.00 - 34.50    4.946   .331   201.88      4.543   .202    137.99
3542   113.50 - 114.00   34.50 - 35.00    4.907   .286   200.21      5.023   .232    183.38
3543   113.50 - 114.00   35.00 - 35.50    4.810   .230   177.25      5.019   .230    171.65
3544   113.50 - 114.00   35.50 - 36.00    4.723   .210   148.84      5.006   .235    152.48
3545   113.50 - 114.00   36.00 - 36.50    4.545   .160   113.08      4.961   .240    111.20
3546   113.50 - 114.00   36.50 - 37.00    4.467   .163    90.31      4.949   .235     98.85
3547   113.50 - 114.00   37.00 - 37.50    4.369   .188    38.48      4.936   .242     68.14
3548   113.50 - 114.00   37.50 - 38.00    4.371   .168    49.58      4.934   .241     95.51
3549   113.50 - 114.00   38.00 - 38.50    4.415   .133    78.41      4.935   .241    123.42
3550   113.50 - 114.00   38.50 - 39.00    4.420   .132    96.72      4.932   .243    143.56
3551   113.50 - 114.00   39.00 - 39.50    4.388   .150   108.17      4.934   .241    159.79
3552   113.50 - 114.00   39.50 - 40.00    4.430   .134   112.64      4.928   .245    183.27
3553   113.50 - 114.00   40.00 - 40.50    4.430   .134   100.67      3.970   .162    122.64
3554   113.50 - 114.00   40.50 - 41.00    4.428   .138   103.12      3.952   .143    121.42
3555   113.50 - 114.00   41.00 - 41.50    4.442   .136   103.99      3.939   .134    102.52
3556   113.50 - 114.00   41.50 - 42.00    4.247   .181    78.53      4.043   .121     45.86
3557   113.50 - 114.00   42.00 - 42.50    4.474   .199    82.36      4.036   .212    101.58
3558   113.50 - 114.00   42.50 - 43.00    4.485   .196   102.72      4.074   .237    105.00
3559   113.50 - 114.00   43.00 - 43.50    4.480   .196   114.35      4.082   .243     89.15
3560   113.50 - 114.00   43.50 - 44.00    4.542   .165   113.59      4.080   .243     67.19
3561   113.50 - 114.00   44.00 - 44.50    4.644   .141   124.25      4.079   .243     56.90
3562   113.50 - 114.00   44.50 - 45.00    4.628   .137   114.14      4.066   .238     62.60
3563   113.50 - 114.00   45.00 - 45.50    4.612   .144    97.27      4.174   .321     72.98
3564   113.50 - 114.00   45.50 - 46.00    4.624   .135   101.96      4.169   .317     83.24
3565   113.50 - 114.00   46.00 - 46.50    4.620   .136    91.12      4.157   .307     83.13
3566   113.50 - 114.00   46.50 - 47.00    4.608   .141    74.93      4.154   .305     68.39
3567   113.50 - 114.00   47.00 - 47.50    4.601   .147    40.01      4.311   .242     55.48
3568   113.50 - 114.00   47.50 - 48.00    4.399   .108    82.13      4.304   .134     34.55
3569   113.50 - 114.00   48.00 - 48.50    4.371   .114    41.64      4.252   .161     41.47
3570   113.50 - 114.00   48.50 - 49.00    4.363   .125    86.62      4.232   .169     71.22
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*                                 * SEISMIC MAP OF CONTINENTAL U.S. *                                *
*****************************************************************************************************
*    GRID      LONG1 - LONG2        LAT1 - LAT2          A(H)     D(H)     R(H)         A(N)   D(N)     R(N)    *
*****************************************************************************************************
*                                                                                                   *
*    3571     113.50 - 114.00     49.00 - 49.50         4.290    .141    114.81        4.211   .182     59.03   *
*    3572     113.50 - 114.00     49.50 - 50.00         3.923    .124    116.06        4.207   .189     63.74   *
*    3573     114.00 - 114.50     31.00 - 31.50         4.671    .376    162.68        4.922   .233     18.61   *
*    3574     114.00 - 114.50     31.50 - 32.00         4.706    .357    130.41        4.938   .242     35.71   *
*    3575     114.00 - 114.50     32.00 - 32.50         4.714    .351    100.68        4.934   .240     74.72   *
*    3576     114.00 - 114.50     32.50 - 33.00         4.720    .342     68.52        4.933   .239     98.68   *
*    3577     114.00 - 114.50     33.00 - 33.50         4.756    .319     98.81        4.902   .234    115.23   *
*    3578     114.00 - 114.50     33.50 - 34.00         4.762    .315    120.79        4.883   .224    129.93   *
*    3579     114.00 - 114.50     34.00 - 34.50         4.774    .301    142.06        5.156   .242    168.45   *
*    3580     114.00 - 114.50     34.50 - 35.00         4.778    .295    152.73        5.096   .231    168.23   *
*    3581     114.00 - 114.50     35.00 - 35.50         4.739    .258    139.19        5.061   .227    155.43   *
*    3582     114.00 - 114.50     35.50 - 36.00         4.782    .291    116.12        5.057   .222    135.15   *
*    3583     114.00 - 114.50     36.00 - 36.50         4.983    .257    121.04        5.048   .222    115.35   *
*    3584     114.00 - 114.50     36.50 - 37.00         4.859    .255    125.96        5.002   .223     84.51   *
*    3585     114.00 - 114.50     37.00 - 37.50         4.753    .256     73.86        4.988   .219     30.27   *
*    3586     114.00 - 114.50     37.50 - 38.00         4.781    .314    124.01        4.961   .227     81.64   *
*    3587     114.00 - 114.50     38.00 - 38.50         4.763    .311    143.17        4.960   .224    112.65   *
*    3588     114.00 - 114.50     38.50 - 39.00         4.775    .310    159.69        4.959   .224    133.83   *
*    3589     114.00 - 114.50     39.00 - 39.50         4.793    .300    170.59        4.953   .228    124.77   *
*    3590     114.00 - 114.50     39.50 - 40.00         4.747    .312    157.08        4.954   .227    174.56   *
*    3591     114.00 - 114.50     40.00 - 40.50         4.742    .313     80.76        4.952   .225    198.98   *
*    3592     114.00 - 114.50     40.50 - 41.00         4.741    .313    149.87        4.141   .153    142.46   *
*    3593     114.00 - 114.50     41.00 - 41.50         4.743    .312    157.56        4.173   .164    134.22   *
*    3594     114.00 - 114.50     41.50 - 42.00         4.829    .336    164.55        4.215   .201    113.00   *
*    3595     114.00 - 114.50     42.00 - 42.50         4.447    .204    109.72        4.068   .155    118.19   *
*    3596     114.00 - 114.50     42.50 - 43.00         4.461    .197    101.58        4.099   .179    113.85   *
*    3597     114.00 - 114.50     43.00 - 43.50         4.456    .197    113.05        4.106   .184     88.31   *
*    3598     114.00 - 114.50     43.50 - 44.00         4.518    .174     66.58        4.061   .225     39.17   *
*    3599     114.00 - 114.50     44.00 - 44.50         4.626    .149    114.57        4.053   .220     27.96   *
*    3600     114.00 - 114.50     44.50 - 45.00         4.611    .141    116.80        4.040   .216     48.05   *
*    3601     114.00 - 114.50     45.00 - 45.50         4.612    .144    116.82        4.168   .316     76.70   *
*    3602     114.00 - 114.50     45.50 - 46.00         4.624    .135    117.55        4.163   .312     89.69   *
*    3603     114.00 - 114.50     46.00 - 46.50         4.620    .136    109.38        4.151   .301     89.46   *
*    3604     114.00 - 114.50     46.50 - 47.00         4.608    .141     93.91        4.149   .300     73.68   *
*    3605     114.00 - 114.50     47.00 - 47.50         4.601    .147     58.80        4.306   .239     51.57   *
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*                          * SEISMIC MAP OF CONTINENTAL U.S. *                                *
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*  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)       A(N)   C(N)    R(N)   *
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*
*  3606    114.00 - 114.50    47.50 - 48.00      4.399   .108    49.78      4.302   .135    15.36  *
*  3607    114.00 - 114.50    48.00 - 48.50      4.371   .114    29.22      4.249   .163    35.13  *
*  3608    114.00 - 114.50    48.50 - 49.00      4.363   .125    83.59      4.237   .169    67.83  *
*  3609    114.00 - 114.50    49.00 - 49.50      4.290   .141   121.88      4.211   .182    56.91  *
*  3610    114.00 - 114.50    49.50 - 50.00      3.923   .124   123.71      4.203   .189    35.83  *
*  3611    114.50 - 115.00    31.00 - 31.50      4.691   .360   145.71      4.937   .241    38.58  *
*  3612    114.50 - 115.00    31.50 - 32.00      4.761   .330   110.27      4.993   .210    63.48  *
*  3613    114.50 - 115.00    32.00 - 32.50      4.768   .326    49.13      4.990   .209    69.70  *
*  3614    114.50 - 115.00    32.50 - 33.00      4.784   .317    80.46      4.991   .208    79.54  *
*  3615    114.50 - 115.00    33.00 - 33.50      4.814   .299    49.83      4.964   .205   104.18  *
*  3616    114.50 - 115.00    33.50 - 34.00      4.904   .324   108.53      4.944   .197   116.84  *
*  3617    114.50 - 115.00    34.00 - 34.50      4.914   .312   137.42      5.181   .242   151.65  *
*  3618    114.50 - 115.00    34.50 - 35.00      4.917   .307   153.35      5.128   .229   153.86  *
*  3619    114.50 - 115.00    35.00 - 35.50      4.903   .288   142.78      5.099   .221   143.22  *
*  3620    114.50 - 115.00    35.50 - 36.00      4.930   .305    74.91      5.097   .218    98.44  *
*  3621    114.50 - 115.00    36.00 - 36.50      5.203   .331    62.01      5.092   .214    86.09  *
*  3622    114.50   115.00    36.50 - 37.00      5.136   .349   147.65      5.054   .209    84.16  *
*  3623    114.50 - 115.00    37.00 - 37.50      5.054   .366   168.57      5.038   .206    67.35  *
*  3624    114.50 - 115.00    37.50 - 38.00      5.044   .410   190.81      4.985   .210    78.39  *
*  3625    114.50 - 115.00    38.00 - 38.50      5.030   .413   204.70      4.984   .208   101.32  *
*  3626    114.50 - 115.00    38.50 - 39.00      5.038   .409   215.96      4.980   .209   123.04  *
*  3627    114.50 - 115.00    39.00 - 39.50      5.035   .406   219.16      4.972   .213   120.59  *
*  3628    114.50 - 115.00    39.50 - 40.00      5.003   .425   208.50      4.971   .215   166.23  *
*  3629    114.50 - 115.00    40.00 - 40.50      4.881   .380   165.27      4.968   .215   190.42  *
*  3630    114.50 - 115.00    40.50 - 41.00      4.872   .388   174.32      4.252   .155   150.28  *
*  3631    114.50 - 115.00    41.00 - 41.50      4.870   .389   186.23      4.253   .148   152.62  *
*  3632    114.50 - 115.00    41.50 - 42.00      4.897   .409   194.65      4.243   .205   144.63  *
*  3633    114.50 - 115.00    42.00 - 42.50      4.421   .219   118.84      3.974   .077   127.43  *
*  3634    114.50 - 115.00    42.50 - 43.00      4.426   .213    52.23      4.004   .101   114.66  *
*  3635    114.50 - 115.00    43.00 - 43.50      4.413   .218   113.27      4.014   .108    85.85  *
*  3636    114.50 - 115.00    43.50 - 44.00      4.239   .083    87.50      3.967   .149    43.01  *
*  3637    114.50 - 115.00    44.00 - 44.50      4.460   .151    60.91      3.952   .138    18.46  *
*  3638    114.50 - 115.00    44.50 - 45.00      4.438   .120    79.12      3.934   .135    47.48  *
*  3639    114.50 - 115.00    45.00 - 45.50      4.616   .153   118.97      4.149   .300    52.19  *
*  3640    114.50 - 115.00    45.50 - 46.00      4.627   .147   131.25      4.147   .299    92.99  *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GFIC	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
3641	114.50 - 115.00	46.00 - 46.50	4.623	.151	126.17	4.137	.290	95.13
3642	114.50 - 115.00	46.50 - 47.00	4.614	.157	111.85	4.135	.289	79.24
3643	114.50 - 115.00	47.00 - 47.50	4.610	.162	92.37	4.293	.234	60.12
3644	114.50 - 115.00	47.50 - 48.00	4.435	.140	78.03	4.293	.134	34.69
3645	114.50 - 115.00	48.00 - 48.50	4.409	.148	66.77	4.295	.289	54.91
3646	114.50 - 115.00	48.50 - 49.00	4.402	.158	99.59	4.285	.290	73.95
3647	114.50 - 115.00	49.00 - 49.50	4.290	.141	129.61	4.272	.293	53.48
3648	114.50 - 115.00	49.50 - 50.00	3.923	.124	129.78	4.268	.296	15.86
3649	115.00 - 115.50	31.00 - 31.50	4.745	.334	136.17	4.988	.208	59.03
3650	115.00 - 115.50	31.50 - 32.00	4.807	.325	99.87	4.998	.213	59.05
3651	115.00 - 115.50	32.00 - 32.50	4.850	.294	55.97	4.998	.212	66.23
3652	115.00 - 115.50	32.50 - 33.00	4.864	.286	62.72	4.996	.211	70.63
3653	115.00 - 115.50	33.00 - 33.50	4.884	.270	46.81	4.973	.209	78.89
3654	115.00 - 115.50	33.50 - 34.00	4.962	.288	91.92	4.959	.201	92.31
3655	115.00 - 115.50	34.00 - 34.50	4.971	.277	119.11	5.188	.241	129.58
3656	115.00 - 115.50	34.50 - 35.00	4.985	.264	141.90	5.138	.226	137.83
3657	115.00 - 115.50	35.00 - 35.50	4.970	.248	143.97	5.110	.218	133.18
3658	115.00 - 115.50	35.50 - 36.00	4.997	.262	117.33	5.109	.214	116.72
3659	115.00 - 115.50	36.00 - 36.50	5.287	.285	67.49	5.104	.210	94.96
3660	115.00 - 115.50	36.50 - 37.00	5.244	.295	163.59	5.067	.205	68.59
3661	115.00 - 115.50	37.00 - 37.50	5.185	.303	204.94	5.051	.202	52.73
3662	115.00 - 115.50	37.50 - 38.00	5.164	.344	220.63	4.995	.203	55.90
3663	115.00 - 115.50	38.00 - 38.50	5.136	.350	224.23	4.993	.201	88.24
3664	115.00 - 115.50	38.50 - 39.00	5.101	.380	222.52	4.986	.205	110.52
3665	115.00 - 115.50	39.00 - 39.50	5.095	.381	222.88	4.978	.209	133.31
3666	115.00 - 115.50	39.50 - 40.00	5.071	.401	218.19	4.974	.212	158.52
3667	115.00 - 115.50	40.00 - 40.50	4.963	.371	181.65	4.969	.215	176.73
3668	115.00 - 115.50	40.50 - 41.00	4.949	.385	151.45	4.247	.152	136.86
3669	115.00 - 115.50	41.00 - 41.50	4.909	.414	184.20	4.235	.136	149.19
3670	115.00 - 115.50	41.50 - 42.00	4.902	.409	207.42	4.191	.170	149.88
3671	115.00 - 115.50	42.00 - 42.50	4.394	.257	134.61	3.886	.105	128.50
3672	115.00 - 115.50	42.50 - 43.00	4.362	.259	106.31	3.876	.113	111.06
3673	115.00 - 115.50	43.00 - 43.50	4.349	.271	116.41	3.875	.111	84.49
3674	115.00 - 115.50	43.50 - 44.00	4.245	.191	95.11	3.750	.223	47.84
3675	115.00 - 115.50	44.00 - 44.50	4.456	.214	90.18	3.724	.234	22.29

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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                                 *
*****************************************************************************************************
*  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)          A(N)   C(N)    R(N)  *
*****************************************************************************************************
*                                                                                                   *
*  3676    115.00 - 115.50    44.50 - 45.00     4.433   .184     35.15        3.699   .264    29.50  *
*  3677    115.00 - 115.50    45.00 - 45.50     4.451   .147    100.04        4.085   .249    77.96  *
*  3678    115.00 - 115.50    45.50 - 46.00     4.481   .139    128.56        4.095   .257    98.52  *
*  3679    115.00 - 115.50    46.00 - 46.50     4.481   .139    127.38        4.092   .254   100.68  *
*  3680    115.00 - 115.50    46.50 - 47.00     4.472   .145    111.99        4.090   .253    86.83  *
*  3681    115.00 - 115.50    47.00 - 47.50     4.468   .151     61.10        4.249   .224    76.33  *
*  3682    115.00 - 115.50    47.50 - 48.00     4.393   .145     89.07        4.279   .144    63.77  *
*  3683    115.00 - 115.50    48.00 - 48.50     4.373   .151     93.96        4.287   .292    73.80  *
*  3684    115.00 - 115.50    48.50 - 49.00     4.363   .166    115.21        4.278   .293    81.72  *
*  3685    115.00 - 115.50    49.00 - 49.50     4.287   .146    139.51        4.272   .293    61.90  *
*  3686    115.00 - 115.50    49.50 - 50.00     3.913   .138    135.44        4.268   .296    38.07  *
*  3687    115.50 - 116.00    31.00 - 31.50     4.774   .326    128.25        4.988   .210    56.96  *
*  3688    115.50 - 116.00    31.50 - 32.00     4.815   .318     65.34        5.012   .210    53.88  *
*  3689    115.50 - 116.00    32.00 - 32.50     5.005   .372     55.41        5.015   .209    58.85  *
*  3690    115.50 - 116.00    32.50 - 33.00     5.016   .365     30.56        5.016   .208    41.98  *
*  3691    115.50 - 116.00    33.00 - 33.50     5.032   .349     35.11        4.991   .204    38.95  *
*  3692    115.50 - 116.00    33.50 - 34.00     5.079   .394     70.45        4.974   .197    59.50  *
*  3693    115.50 - 116.00    34.00 - 34.50     5.088   .383     87.82        5.195   .244    92.98  *
*  3694    115.50 - 116.00    34.50 - 35.00     5.101   .371    134.19        5.146   .229   121.18  *
*  3695    115.50 - 116.00    35.00 - 35.50     5.094   .359    152.45        5.120   .221   123.17  *
*  3696    115.50 - 116.00    35.50 - 36.00     5.114   .366    149.89        5.119   .217   110.41  *
*  3697    115.50 - 116.00    36.00 - 36.50     5.400   .380    173.78        5.114   .213    84.81  *
*  3698    115.50 - 116.00    36.50 - 37.00     5.363   .393    207.34        5.073   .208    46.90  *
*  3699    115.50 - 116.00    37.00 - 37.50     5.308   .410    230.87        5.058   .205    32.10  *
*  3700    115.50 - 116.00    37.50 - 38.00     5.276   .454    239.41        4.997   .203    48.72  *
*  3701    115.50 - 116.00    38.00 - 38.50     5.249   .464    237.70        4.994   .202    77.31  *
*  3702    115.50 - 116.00    38.50 - 39.00     5.096   .387    208.71        4.985   .206    85.40  *
*  3703    115.50 - 116.00    39.00 - 39.50     5.089   .389    208.04        4.978   .210   123.68  *
*  3704    115.50 - 116.00    39.50 - 40.00     5.061   .415    205.75        4.972   .214   149.73  *
*  3705    115.50 - 116.00    40.00 - 40.50     4.954   .385    165.65        4.966   .217   132.30  *
*  3706    115.50 - 116.00    40.50 - 41.00     4.938   .401     66.90        4.234   .146   105.72  *
*  3707    115.50 - 116.00    41.00 - 41.50     4.896   .432    168.67        4.224   .129   133.15  *
*  3708    115.50 - 116.00    41.50 - 42.00     4.880   .439    210.15        4.205   .067   153.03  *
*  3709    115.50 - 116.00    42.00 - 42.50     4.345   .320    150.91        3.884   .106   130.31  *
*  3710    115.50 - 116.00    42.50 - 43.00     4.234   .318    125.63        3.866   .102   116.49  *
*                                                                                                   *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
3711	115.50 - 116.00	43.00 - 43.50	4.220	.329	101.00	3.857	.095	93.81
3712	115.50 - 116.00	43.50 - 44.00	4.081	.196	61.11	3.734	.209	59.67
3713	115.50 - 116.00	44.00 - 44.50	4.101	.183	65.05	3.704	.214	31.18
3714	115.50 - 116.00	44.50 - 45.00	4.057	.103	52.97	3.680	.248	47.92
3715	115.50 - 116.00	45.00 - 45.50	4.426	.172	107.98	3.984	.340	85.31
3716	115.50 - 116.00	45.50 - 46.00	4.467	.163	135.45	4.013	.353	102.63
3717	115.50 - 116.00	46.00 - 46.50	4.467	.163	136.81	4.013	.353	104.31
3718	115.50 - 116.00	46.50 - 47.00	4.456	.170	123.32	4.010	.352	93.77
3719	115.50 - 116.00	47.00 - 47.50	4.451	.178	96.89	4.282	.138	102.13
3720	115.50 - 116.00	47.50 - 48.00	4.382	.160	75.69	4.240	.148	87.97
3721	115.50 - 116.00	48.00 - 48.50	4.373	.164	98.82	4.278	.289	92.49
3722	115.50 - 116.00	48.50 - 49.00	4.368	.171	126.73	4.276	.292	93.54
3723	115.50 - 116.00	49.00 - 49.50	4.276	.148	148.35	4.277	.294	79.53
3724	115.50 - 116.00	49.50 - 50.00	3.882	.134	139.31	4.272	.296	67.36
3725	116.00 - 116.50	31.00 - 31.50	4.779	.322	126.98	4.996	.203	53.69
3726	116.00 - 116.50	31.50 - 32.00	4.842	.318	80.75	5.032	.210	48.00
3727	116.00 - 116.50	32.00 - 32.50	5.025	.367	83.45	5.034	.210	79.42
3728	116.00 - 116.50	32.50 - 33.00	5.035	.360	73.74	5.034	.209	52.90
3729	116.00 - 116.50	33.00 - 33.50	5.049	.346	48.76	5.015	.205	26.54
3730	116.00 - 116.50	33.50 - 34.00	5.095	.390	72.86	5.000	.198	51.39
3731	116.00 - 116.50	34.00 - 34.50	5.104	.379	77.85	5.207	.246	70.24
3732	116.00 - 116.50	34.50 - 35.00	5.116	.368	92.99	5.160	.231	103.12
3733	116.00 - 116.50	35.00 - 35.50	5.109	.357	139.10	5.131	.224	111.10
3734	116.00 - 116.50	35.50 - 36.00	5.117	.364	154.47	5.132	.219	101.44
3735	116.00 - 116.50	36.00 - 36.50	5.404	.377	211.25	5.126	.216	80.09
3736	116.00 - 116.50	36.50 - 37.00	5.366	.390	218.65	5.087	.211	41.30
3737	116.00 - 116.50	37.00 - 37.50	5.311	.410	224.71	5.072	.207	13.21
3738	116.00 - 116.50	37.50 - 38.00	5.272	.457	224.59	4.994	.203	40.23
3739	116.00 - 116.50	38.00 - 38.50	5.236	.474	214.24	4.991	.202	71.78
3740	116.00 - 116.50	38.50 - 39.00	5.075	.406	180.42	4.981	.207	57.55
3741	116.00 - 116.50	39.00 - 39.50	5.060	.415	177.41	4.985	.209	116.72
3742	116.00 - 116.50	39.50 - 40.00	5.032	.441	180.51	4.980	.212	144.04
3743	116.00 - 116.50	40.00 - 40.50	4.919	.411	159.44	4.974	.215	127.66
3744	116.00 - 116.50	40.50 - 41.00	4.901	.429	138.24	4.299	.139	56.58
3745	116.00 - 116.50	41.00 - 41.50	4.854	.463	169.86	4.291	.123	119.02

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                          * SEISMIC MAP OF CONTINENTAL U.S. *

   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

   3746    116.00 - 116.50    41.50 - 42.00      4.823   .471   200.98       4.286   .081   145.98
   3747    116.00 - 116.50    42.00 - 42.50      4.296   .340   151.67       3.786   .219   117.30
   3748    116.00 - 116.50    42.50 - 43.00      4.126   .394   123.47       3.749   .198   110.67
   3749    116.00 - 116.50    43.00 - 43.50      4.111   .402    83.83       3.736   .190    94.94
   3750    116.00 - 116.50    43.50 - 44.00      3.986   .174    23.65       3.760   .132    77.79
   3751    116.00 - 116.50    44.00 - 44.50      4.002   .173    37.65       3.706   .183    58.13
   3752    116.00 - 116.50    44.50 - 45.00      4.056   .140    41.20       3.657   .232    41.40
   3753    116.00 - 116.50    45.00 - 45.50      4.094   .080    88.34       3.976   .336    93.70
   3754    116.00 - 116.50    45.50 - 46.00      4.170   .129   110.84       4.007   .349   111.00
   3755    116.00 - 116.50    46.00 - 46.50      4.170   .129   114.57       4.007   .349   113.88
   3756    116.00 - 116.50    46.50 - 47.00      4.155   .127   106.02       4.004   .348   107.06
   3757    116.00 - 116.50    47.00 - 47.50      4.147   .135    79.12       4.276   .142   123.84
   3758    116.00 - 116.50    47.50 - 48.00      4.094   .122    26.94       4.233   .153   111.09
   3759    116.00 - 116.50    48.00 - 48.50      4.080   .117    63.70       4.275   .290   110.15
   3760    116.00 - 116.50    48.50 - 49.00      4.072   .129    98.36       4.279   .292   107.01
   3761    116.00 - 116.50    49.00 - 49.50      3.965   .136   123.09       4.277   .294    96.94
   3762    116.00 - 116.50    49.50 - 50.00      3.907   .137   147.71       4.274   .295    89.38
   3763    116.50 - 117.00    31.00 - 31.50      4.805   .322   130.01       5.009   .201    73.74
   3764    116.50 - 117.00    31.50 - 32.00      4.871   .342    55.15       5.025   .205    65.93
   3765    116.50 - 117.00    32.00 - 32.50      5.043   .378    86.70       5.033   .207    69.43
   3766    116.50 - 117.00    32.50 - 33.00      5.058   .372   103.43       5.036   .206    57.11
   3767    116.50 - 117.00    33.00 - 33.50      5.072   .358    74.38       5.016   .203    50.90
   3768    116.50 - 117.00    33.50 - 34.00      5.116   .399    50.44       5.003   .199    39.11
   3769    116.50 - 117.00    34.00 - 34.50      5.124   .389    45.60       5.211   .246    49.95
   3770    116.50 - 117.00    34.50 - 35.00      5.137   .377   107.35       5.163   .230    67.31
   3771    116.50 - 117.00    35.00 - 35.50      5.129   .369    99.44       5.137   .223    86.42
   3772    116.50 - 117.00    35.50 - 36.00      5.135   .377   145.17       5.136   .219    68.91
   3773    116.50 - 117.00    36.00 - 36.50      5.424   .387   190.59       5.139   .220    82.89
   3774    116.50 - 117.00    36.50 - 37.00      5.401   .393   204.90       5.103   .214    51.33
   3775    116.50 - 117.00    37.00 - 37.50      5.353   .409   209.73       5.089   .210    24.63
   3776    116.50 - 117.00    37.50 - 38.00      5.300   .449   203.77       5.016   .204    48.83
   3777    116.50 - 117.00    38.00 - 38.50      5.268   .462   186.11       5.012   .203    75.27
   3778    116.50 - 117.00    38.50 - 39.00      5.108   .397   146.43       5.004   .207    93.23
   3779    116.50 - 117.00    39.00 - 39.50      5.084   .404   137.69       5.004   .210   118.02
   3780    116.50 - 117.00    39.50 - 40.00      5.057   .430   152.89       4.996   .214   138.37
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                         * SEISMIC MAP OF CONTINENTAL U.S. *

   GRID   LONG1 - LONG2    LAT1 - LAT2      A(H)    B(H)    R(H)        A(V)    B(V)    R(V)

   3781   116.50 - 117.00   40.00 - 40.50    4.949   .402   146.38      4.991   .216   145.61
   3782   116.50 - 117.00   40.50 - 41.00    4.[illegible]32   .421   149.22      4.299   .245    80.75
   3783   116.50 - 117.00   41.00 - 41.50    4.892   .450   167.15      4.296   .236    96.38
   3784   116.50 - 117.00   41.50 - 42.00    4.875   .444   198.77      4.273   .219   124.37
   3785   116.50 - 117.00   42.00 - 42.50    4.404   .313   165.53      4.041   .112   129.05
   3786   116.50 - 117.00   42.50 - 43.00    4.246   .371   147.38      4.015   .098   132.07
   3787   116.50 - 117.00   43.00 - 43.50    4.228   .391   110.70      4.005   .089   124.72
   3788   116.50 - 117.00   43.50 - 44.00    3.895   .209    53.02      3.922   .143   101.01
   3789   116.50 - 117.00   44.00 - 44.50    3.915   .195    61.71      3.897   .140    79.99
   3790   116.50 - 117.00   44.50 - 45.00    3.986   .138    67.31      3.874   .147    68.48
   3791   116.50 - 117.00   45.00 - 45.50    4.099   .105    93.81      4.125   .116   115.54
   3792   116.50 - 117.00   45.50 - 46.00    4.183   .148    98.45      4.167   .103   143.50
   3793   116.50 - 117.00   46.00 - 46.50    4.183   .148   109.56      4.167   .103   150.12
   3794   116.50 - 117.00   46.50 - 47.00    4.150   .133   107.11      4.163   .106   145.45
   3795   116.50 - 117.00   47.00 - 47.50    4.142   .143    87.11      4.234   .155   140.95
   3796   116.50 - 117.00   47.50 - 48.00    4.089   .131    55.82      4.216   .174   131.45
   3797   116.50 - 117.00   48.00 - 48.50    4.075   .127    35.95      4.271   .294   126.16
   3798   116.50 - 117.00   48.50 - 49.00    4.066   .140    95.57      4.275   .296   119.97
   3799   116.50 - 117.00   49.00 - 49.50    3.989   .145   130.41      4.275   .296   110.40
   3800   116.50 - 117.00   49.50 - 50.00    3.945   .132   158.07      4.273   .296   100.75
   3801   117.00 - 117.50   31.00 - 31.50    4.835   .348   155.36      4.942   .192    83.45
   3802   117.00 - 117.50   31.50 - 32.00    4.887   .336   123.72      5.015   .202    50.72
   3803   117.00 - 117.50   32.00 - 32.50    5.055   .370   135.23      5.023   .203    65.04
   3804   117.00 - 117.50   32.50 - 33.00    5.076   .363   121.07      5.039   .204    89.08
   3805   117.00 - 117.50   33.00 - 33.50    5.096   .346    71.71      5.019   .203    81.03
   3806   117.00 - 117.50   33.50 - 34.00    5.140   .385    71.54      5.011   .201    69.01
   3807   117.00 - 117.50   34.00 - 34.50    5.147   .377    62.43      5.215   .247    51.20
   3808   117.00 - 117.50   34.50 - 35.00    5.158   .367   106.17      5.169   .230    88.53
   3809   117.00 - 117.50   35.00 - 35.50    5.148   .361   124.45      5.145   .223    76.89
   3810   117.00 - 117.50   35.50 - 36.00    5.155   .368   132.12      5.143   .219    95.38
   3811   117.00 - 117.50   36.00 - 36.50    5.268   .377    88.53      5.147   .220    81.55
   3812   117.00 - 117.50   36.50 - 37.00    5.247   .381   141.42      5.111   .215    70.68
   3813   117.00 - 117.50   37.00 - 37.50    5.203   .395   147.15      5.098   .210    54.49
   3814   117.00 - 117.50   37.50 - 38.00    5.158   .430   149.61      5.026   .203    65.01
   3815   117.00 - 117.50   38.00 - 38.50    5.118   .447   126.64      5.023   .202    65.46
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
3816	117.00 - 117.50	38.50 - 39.00	4.962	.381	83.57	5.014	.205	95.79
3817	117.00 - 117.50	39.00 - 39.50	5.102	.393	76.59	5.006	.209	110.24
3818	117.00 - 117.50	39.50 - 40.00	5.059	.430	122.28	4.998	.213	124.09
3819	117.00 - 117.50	40.00 - 40.50	4.947	.405	113.45	4.991	.216	110.66
3820	117.00 - 117.50	40.50 - 41.00	4.933	.421	106.77	4.298	.243	42.10
3821	117.00 - 117.50	41.00 - 41.50	4.898	.445	135.57	4.298	.238	53.52
3822	117.00 - 117.50	41.50 - 42.00	4.886	.435	183.53	4.276	.221	109.97
3823	117.00 - 117.50	42.00 - 42.50	2.545	.000	69.16	2.881	.147	67.28
3824	117.00 - 117.50	42.50 - 43.00	3.085	.297	81.83	2.294	.225	86.67
3825	117.00 - 117.50	43.00 - 43.50	3.163	.187	60.18	2.548	.000	86.35
3826	117.00 - 117.50	43.50 - 44.00	3.244	.075	49.78	3.012	.014	60.09
3827	117.00 - 117.50	44.00 - 44.50	3.244	.075	47.10	3.012	.014	23.31
3828	117.00 - 117.50	44.50 - 45.00	3.290	.023	23.14	3.012	.014	14.78
3829	117.00 - 117.50	45.00 - 45.50	3.355	.427	52.49	3.012	.014	44.26
3830	117.00 - 117.50	45.50 - 46.00	3.334	.433	24.01	2.923	.074	73.16
3831	117.00 - 117.50	46.00 - 46.50	3.281	.459	46.08	.000	.000	.00
3832	117.00 - 117.50	46.50 - 47.00	3.498	.282	64.95	.000	.000	.00
3833	117.00 - 117.50	47.00 - 47.50	3.571	.277	63.60	.000	.000	.00
3834	117.00 - 117.50	47.50 - 48.00	3.244	.075	21.17	.000	.000	.00
3835	117.00 - 117.50	48.00 - 48.50	3.244	.075	33.86	.000	.000	.00
3836	117.00 - 117.50	48.50 - 49.00	3.244	.075	55.95	.000	.000	.00
3837	117.00 - 117.50	49.00 - 49.50	2.722	.490	70.02	.000	.000	.00
3838	117.00 - 117.50	49.50 - 50.00	.000	.000	.00	3.821	.363	82.26
3839	117.50 - 118.00	31.00 - 31.50	4.835	.348	181.17	4.820	.163	115.34
3840	117.50 - 118.00	31.50 - 32.00	4.887	.336	158.48	4.999	.196	107.90
3841	117.50 - 118.00	32.00 - 32.50	5.062	.369	157.06	5.008	.195	105.53
3842	117.50 - 118.00	32.50 - 33.00	5.083	.361	131.14	5.022	.195	77.79
3843	117.50 - 118.00	33.00 - 33.50	5.108	.341	103.66	5.022	.193	80.02
3844	117.50 - 118.00	33.50 - 34.00	5.164	.369	62.88	5.028	.194	60.82
3845	117.50 - 118.00	34.00 - 34.50	5.170	.361	69.86	5.224	.253	43.91
3846	117.50 - 118.00	34.50 - 35.00	5.179	.354	76.32	5.186	.237	86.94
3847	117.50 - 118.00	35.00 - 35.50	5.171	.347	110.72	5.164	.231	76.14
3848	117.50 - 118.00	35.50 - 36.00	5.178	.353	114.46	5.164	.227	72.19
3849	117.50 - 118.00	36.00 - 36.50	5.292	.362	125.87	5.167	.228	76.07
3850	117.50 - 118.00	36.50 - 37.00	5.277	.362	89.01	5.133	.224	89.36

* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
3851	117.50 - 118.00	37.00 - 37.50	5.236	.375	94.55	5.122	.219	71.21
3852	117.50 - 118.00	37.50 - 38.00	5.197	.404	128.63	5.055	.212	74.33
3853	117.50 - 118.00	38.00 - 38.50	5.162	.418	103.07	5.034	.200	73.29
3854	117.50 - 118.00	38.50 - 39.00	5.008	.348	36.91	5.026	.202	71.35
3855	117.50 - 118.00	39.00 - 39.50	5.150	.359	83.71	5.018	.205	76.61
3856	117.50 - 118.00	39.50 - 40.00	5.100	.397	95.99	5.008	.209	81.56
3857	117.50 - 118.00	40.00 - 40.50	4.965	.400	67.17	4.990	.215	134.84
3858	117.50 - 118.00	40.50 - 41.00	4.953	.414	47.69	4.297	.242	64.53
3859	117.50 - 118.00	41.00 - 41.50	4.923	.434	86.08	4.297	.237	56.25
3860	117.50 - 118.00	41.50 - 42.00	4.906	.426	173.27	4.274	.220	99.58
3861	117.50 - 118.00	42.00 - 42.50	2.545	.000	64.82	2.881	.147	58.76
3862	117.50 - 118.00	42.50 - 43.00	3.085	.297	97.61	2.296	.225	74.32
3863	117.50 - 118.00	43.00 - 43.50	3.163	.187	79.93	2.071	.000	73.97
3864	117.50 - 118.00	43.50 - 44.00	3.244	.075	69.34	2.957	.041	63.98
3865	117.50 - 118.00	44.00 - 44.50	3.244	.075	62.40	2.957	.041	37.84
3866	117.50 - 118.00	44.50 - 45.00	3.290	.023	51.33	2.957	.041	19.63
3867	117.50 - 118.00	45.00 - 45.50	3.514	.345	63.93	2.957	.041	43.19
3868	117.50 - 118.00	45.50 - 46.00	3.495	.358	44.89	2.923	.074	72.78
3869	117.50 - 118.00	46.00 - 46.50	3.448	.400	32.01	.000	.000	.00
3870	117.50 - 118.00	46.50 - 47.00	3.610	.247	57.65	.000	.000	.00
3871	117.50 - 118.00	47.00 - 47.50	3.650	.275	74.86	2.071	.000	98.03
3872	117.50 - 118.00	47.50 - 48.00	3.244	.075	44.91	2.071	.000	77.72
3873	117.50 - 118.00	48.00 - 48.50	3.244	.075	53.40	2.071	.000	69.64
3874	117.50 - 118.00	48.50 - 49.00	3.244	.075	70.78	2.071	.000	77.72
3875	117.50 - 118.00	49.00 - 49.50	2.722	.490	79.65	2.071	.000	98.03
3876	117.50 - 118.00	49.50 - 50.00	.000	.000	.00	3.821	.363	73.06
3877	118.00 - 118.50	32.00 - 32.50	5.075	.381	169.32	4.891	.163	112.36
3878	118.00 - 118.50	32.50 - 33.00	5.097	.373	99.21	4.916	.161	80.78
3879	118.00 - 118.50	33.00 - 33.50	5.122	.353	105.50	4.927	.162	86.75
3880	118.00 - 118.50	33.50 - 34.00	5.188	.368	44.03	4.955	.171	47.30
3881	118.00 - 118.50	34.00 - 34.50	5.209	.350	64.35	5.184	.236	37.32
3882	118.00 - 118.50	34.50 - 35.00	5.218	.342	78.50	5.184	.234	75.83
3883	118.00 - 118.50	35.00 - 35.50	5.211	.335	85.57	5.167	.229	70.86
3884	118.00 - 118.50	35.50 - 36.00	5.218	.341	68.21	5.167	.226	77.85
3885	118.00 - 118.50	36.00 - 36.50	5.330	.348	115.68	5.170	.226	78.18

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*                       * SEISMIC MAP OF CONTINENTAL U.S. *
*   GRID    LONG1 - LONG2      LAT1 - LAT2      A(H)   C(H)    R(H)       A(N)   C(N)    R(N)   *
*
*   3886   118.00 - 118.50   36.50 - 37.00     5.317  .348    48.29      5.137  .222    92.87   *
*   3887   118.00 - 118.50   37.00 - 37.50     5.280  .360    89.58      5.126  .217    84.76   *
*   3888   118.00 - 118.5    37.50 - 38.00     5.248  .383   104.64      5.059  .208    49.45   *
*   3889   118.00 - 118.50   38.00 - 38.50     5.204  .386    64.88      5.037  .196    59.57   *
*   3890   118.00 - 118.50   38.50 - 39.00     5.059  .310    73.16      5.028  .198    63.45   *
*   3891   118.00 - 118.50   39.00 - 39.50     5.206  .318    43.39      5.021  .200    47.66   *
*   3892   118.00 - 118.50   39.50 - 40.00     5.168  .345    53.83      5.011  .204    83.58   *
*   3893   118.00 - 118.50   40.00 - 40.50     5.026  .361    97.83      4.984  .210   138.41   *
*   3894   118.00 - 118.50   40.50 - 41.00     4.967  .404   102.52      4.334  .270    93.44   *
*   3895   118.00 - 118.50   41.00 - 41.50     4.930  .430   130.95      4.303  .244    93.17   *
*   3896   118.00 - 118.50   41.50 - 42.00     4.913  .422   176.52      4.276  .226    64.76   *
*   3897   118.00 - 118.5    42.00 - 42.50     2.545  .000    69.16      3.676  .135    70.68   *
*   3898   118.00 - 118.50   42.50 - 43.00      .000  .000      .00      3.627  .148    82.90   *
*   3899   118.00 - 118.5    43.00 - 43.50      .000  .000      .00      3.621  .141   102.15   *
*   3900   118.00 - 118.50   43.50 - 44.00     2.423  .000    85.22      2.923  .074    71.44   *
*   3901   118.00 - 118.50   44.00 - 44.50     2.423  .000    60.76      2.923  .074    43.95   *
*   3902   118.00 - 118.50   44.50 - 45.00     2.900  .000    64.00      2.923  .074    15.68   *
*   3903   118.00 - 118.50   45.00 - 45.50     3.471  .378    65.06      2.923  .074    45.43   *
*   3904   118.00 - 118.50   45.50 - 46.00     3.558  .299    42.21      2.884  .114    75.80   *
*   3905   118.00 - 118.50   46.00 - 46.50     3.539  .322    14.13      2.296  .225    98.98   *
*   3906   118.00 - 118.50   46.50 - 47.00     3.558  .299    46.83      2.296  .225    78.91   *
*   3907   118.00 - 118.50   47.00 - 47.50     3.646  .307    79.98      2.446  .074    70.94   *
*   3908   118.00 - 118.50   47.50 - 48.00     3.237  .195    69.48      2.446  .074    65.11   *
*   3909   118.00 - 118.50   48.00 - 48.50     3.114  .213    65.27      2.446  .074    61.13   *
*   3910   118.00 - 118.50   48.50 - 49.00     3.114  .213    76.71      2.071  .000    58.32   *
*   3911   118.00 - 118.50   49.00 - 49.50     3.040  .316    97.32      2.071  .000    83.50   *
*   3912   118.00 - 118.50   49.50 - 50.00      .000  .000      .00      3.821  .363    69.72   *
*   3913   118.50 - 119.00   32.00 - 32.50     5.048  .363   180.98      4.883  .161    88.60   *
*   3914   118.50 - 119.00   32.50 - 33.00     5.069  .362   147.50      4.908  .159   105.35   *
*   3915   118.50 - 119.00   33.00 - 33.50     5.091  .347   116.71      4.919  .159    86.88   *
*   3916   118.50 - 119.00   33.50 - 34.00     5.165  .364    78.16      4.950  .170    68.27   *
*   3917   118.50 - 119.00   34.00 - 34.50     5.196  .345    49.27      5.181  .236    53.28   *
*   3918   118.50 - 119.00   34.50 - 35.00     5.234  .336    53.83      5.185  .234    85.36   *
*   3919   118.50 - 119.00   35.00 - 35.50     5.244  .334    40.35      5.168  .229    66.81   *
*   3920   118.50 - 119.00   35.50 - 36.00     5.267  .347    80.52      5.168  .226   108.52   *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
3521	118.50 - 119.00	36.00 - 36.50	5.378	.353	101.96	5.172	.227	102.92
3522	118.50 - 119.00	36.50 - 37.00	5.376	.353	114.79	5.141	.224	112.80
3523	118.50 - 119.00	37.00 - 37.50	5.345	.362	96.63	5.130	.219	72.57
3524	118.50 - 119.00	37.50 - 38.00	5.317	.384	53.07	5.064	.210	66.87
3525	118.50 - 119.00	38.00 - 38.50	5.281	.386	106.91	5.042	.198	79.44
3526	118.50 - 119.00	38.50 - 39.00	5.152	.327	75.64	5.034	.199	69.99
3527	118.50 - 119.00	39.00 - 39.50	5.308	.331	48.94	5.027	.201	70.79
3528	118.50 - 119.00	39.50 - 40.00	5.282	.347	70.61	5.019	.204	97.90
3529	118.50 - 119.00	40.00 - 40.50	5.172	.383	116.51	4.990	.209	143.05
3530	118.50 - 119.00	40.50 - 41.00	5.104	.417	135.81	4.358	.277	100.17
3531	118.50 - 119.00	41.00 - 41.50	4.999	.450	152.32	4.300	.241	100.74
3532	118.50 - 119.00	41.50 - 42.00	4.942	.428	183.95	4.274	.224	90.39
3533	118.50 - 119.00	42.00 - 42.50	2.545	.000	80.79	3.676	.135	52.89
3534	118.50 - 119.00	42.50 - 43.00	.000	.000	.00	3.627	.148	62.26
3535	118.50 - 119.00	43.00 - 43.50	.000	.000	.00	3.621	.141	86.12
3536	118.50 - 119.00	43.50 - 44.00	2.423	.000	101.31	2.923	.074	82.63
3537	118.50 - 119.00	44.00 - 44.50	2.423	.000	81.81	2.923	.074	56.50
3538	118.50 - 119.00	44.50 - 45.00	2.900	.000	78.30	2.923	.074	38.76
3539	118.50 - 119.00	45.00 - 45.50	3.471	.378	65.03	2.923	.074	57.46
3540	118.50 - 119.00	45.50 - 46.00	3.558	.299	28.13	2.884	.114	84.98
3541	118.50 - 119.00	46.00 - 46.50	3.539	.322	30.49	2.296	.225	83.99
3542	118.50 - 119.00	46.50 - 47.00	3.653	.277	52.63	2.296	.225	59.02
3543	118.50 - 119.00	47.00 - 47.50	3.713	.253	77.08	2.446	.074	50.97
3544	118.50 - 119.00	47.50 - 48.00	3.376	.166	66.53	2.446	.074	48.10
3545	118.50 - 119.00	48.00 - 48.50	3.300	.155	61.28	2.446	.074	35.13
3546	118.50 - 119.00	48.50 - 49.00	3.300	.155	74.58	2.071	.000	42.64
3547	118.50 - 119.00	49.00 - 49.50	3.024	.300	89.82	2.071	.000	73.41
3548	118.50 - 119.00	49.50 - 50.00	.000	.000	.00	3.821	.363	73.06
3549	119.00 - 119.50	32.00 - 32.50	5.036	.370	195.81	4.877	.161	132.78
3550	119.00 - 119.50	32.50 - 33.00	5.058	.363	165.07	4.903	.158	91.27
3551	119.00 - 119.50	33.00 - 33.50	5.078	.354	132.45	4.914	.158	47.73
3552	119.00 - 119.50	33.50 - 34.00	5.153	.369	104.76	4.945	.169	77.53
3553	119.00 - 119.50	34.00 - 34.50	5.166	.350	67.81	5.178	.237	57.49
3554	119.00 - 119.50	34.50 - 35.00	5.243	.341	70.33	5.181	.234	96.94
3555	119.00 - 119.50	35.00 - 35.50	5.253	.338	31.24	5.168	.230	89.78

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*                                    * SEISMIC MAP OF CONTINENTAL U.S. *                                      *
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*  GRID     LONG1 - LONG2      LAT1 - LAT2          A(H)     O(H)     R(H)          A(N)    O(N)     R(N)     *
**************************************************************************************************************
*                                                                                                             *
*  3556    119.00 - 119.50    35.50 - 36.00        5.289    .348     90.55         5.169    .227    109.96    *
*  3557    119.00 - 119.50    36.00 - 36.50        5.400    .353    136.38         5.173    .228    125.00    *
*  3558    119.00 - 119.50    36.50 - 37.00        5.401    .352    146.17         5.142    .224    124.60    *
*  3559    119.00 - 119.50    37.00 - 37.50        5.372    .361    137.37         5.132    .220    115.94    *
*  3560    119.00 - 119.50    37.50 - 38.00        5.346    .382    118.20         5.066    .211    106.95    *
*  3561    119.00 - 119.50    38.00 - 38.50        5.314    .383     99.17         5.044    .199     70.82    *
*  3562    119.00 - 119.50    38.50 - 39.00        5.190    .330    100.84         5.036    .200     88.46    *
*  3563    119.00 - 119.50    39.00 - 39.50        5.348    .333     81.97         5.029    .202    105.52    *
*  3564    119.00 - 119.50    39.50 - 40.00        5.328    .342     71.78         5.020    .205    108.99    *
*  3565    119.00 - 119.50    40.00 - 40.50        5.236    .379    120.11         4.992    .210    140.88    *
*  3566    119.00 - 119.50    40.50 - 41.00        5.178    .408    118.86         4.378    .283     95.42    *
*  3567    119.00 - 119.50    41.00 - 41.50        5.048    .432    146.73         4.327    .254     99.42    *
*  3568    119.00 - 119.50    41.50 - 42.00        4.985    .417    187.10         4.280    .230     76.59    *
*  3569    119.00 - 119.50    42.00 - 42.50        2.789    .000     86.72         3.642    .141     28.03    *
*  3570    119.00 - 119.50    42.50 - 43.00        2.423    .000     84.61         3.627    .148     44.37    *
*  3571    119.00 - 119.50    43.00 - 43.50        2.423    .000    103.99         3.616    .149     74.25    *
*  3572    119.00 - 119.50    43.50 - 44.00         .000    .000       .00         2.534    .014     83.38    *
*  3573    119.00 - 119.50    44.00 - 44.50         .000    .000       .00         2.534    .014     60.94    *
*  3574    119.00 - 119.50    44.50 - 45.00        2.423    .000     73.76         2.534    .014     50.96    *
*  3575    119.00 - 119.50    45.00 - 45.50        3.418    .432     72.40         2.534    .014     60.94    *
*  3576    119.00 - 119.50    45.50 - 46.00        3.539    .322     48.30         2.534    .014     83.38    *
*  3577    119.00 - 119.50    46.00 - 46.50        3.539    .322     20.60         2.298    .225     73.55    *
*  3578    119.00 - 119.50    46.50 - 47.00        3.700    .240     48.63         2.298    .225     42.88    *
*  3579    119.00 - 119.50    47.00 - 47.50        3.758    .213     68.17         2.446    .074     28.91    *
*  3580    119.00 - 119.50    47.50 - 48.00        3.456    .164     51.21         2.446    .074     37.69    *
*  3581    119.00 - 119.50    48.00 - 48.50        3.376    .166     39.82         2.446    .074     14.57    *
*  3582    119.00 - 119.50    48.50 - 49.00        3.376    .166     60.34         2.071    .000     35.92    *
*  3583    119.00 - 119.50    49.00 - 49.50        3.024    .300     77.93         2.071    .000     69.72    *
*  3584    119.00 - 119.50    49.50 - 50.00         .000    .000       .00         3.821    .363     82.26    *
*  3585    119.50 - 120.00    32.00 - 32.50        4.948    .380    203.27         4.841    .163    149.53    *
*  3586    119.50 - 120.00    32.50 - 33.00        4.976    .371    171.29         4.870    .156    121.39    *
*  3587    119.50 - 120.00    33.00 - 33.50        5.001    .359    135.77         4.883    .154     94.88    *
*  3588    119.50 - 120.00    33.50 - 34.00        5.086    .376     84.60         4.919    .161     71.36    *
*  3589    119.50 - 120.00    34.00 - 34.50        5.125    .355     48.42         5.158    .236     37.04    *
*  3590    119.50 - 120.00    34.50 - 35.00        5.191    .345     69.85         5.163    .233     95.67    *
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*                                * SEISMIC MAP OF CONTINENTAL U.S. *                                  *
*******************************************************************************************************
*    GRID    LONG1  - LONG2      LAT1  - LAT2        A(H)    C(H)    R(H)       A(N)    C(N)    R(N)  *
*******************************************************************************************************
*                                                                                                     *
*    3991    119.50 - 120.00     35.00 - 35.50      5.235   .374     77.84      5.152   .228   112.59 *
*    3992    119.50 - 120.00     35.50 - 36.00      5.281   .378    104.21      5.155   .225   111.02 *
*    3993    119.50 - 120.00     36.00 - 36.50      5.414   .381    142.51      5.164   .226   116.95 *
*    3994    119.50 - 120.00     36.50 - 37.00      5.428   .375    152.53      5.137   .223   125.67 *
*    3995    119.50 - 120.00     37.00 - 37.50      5.403   .385    148.92      5.127   .218   130.33 *
*    3996    119.50 - 120.00     37.50 - 38.00      5.377   .405    147.59      5.061   .209   124.58 *
*    3997    119.50 - 120.00     38.00 - 38.50      5.347   .408    138.61      5.040   .197   111.86 *
*    3998    119.50 - 120.00     38.50 - 39.00      5.251   .364     86.20      5.032   .199    68.54 *
*    3999    119.50 - 120.00     39.00 - 39.50      5.410   .369     91.48      5.025   .201    89.16 *
*    4000    119.50 - 120.00     39.50 - 40.00      5.391   .379     86.63      5.016   .204   106.84 *
*    4001    119.50 - 120.00     40.00 - 40.50      5.295   .366    118.19      4.989   .209   108.28 *
*    4002    119.50 - 120.00     40.50 - 41.00      5.248   .395     58.30      4.389   .290    65.88 *
*    4003    119.50 - 120.00     41.00 - 41.50      5.145   .427    145.18      4.341   .263    95.53 *
*    4004    119.50 - 120.00     41.50 - 42.00      5.007   .397    186.24      4.296   .241    66.33 *
*    4005    119.50 - 120.00     42.00 - 42.50      2.423   .000     52.04      3.627   .148    10.11 *
*    4006    119.50 - 120.00     42.50 - 43.00      2.423   .000     62.44      3.627   .148    36.26 *
*    4007    119.50 - 120.00     43.00 - 43.50      2.423   .000     86.43      3.616   .149    69.72 *
*    4008    119.50 - 120.00     43.50 - 44.00       .000   .000       .00      2.446   .074   101.31 *
*    4009    119.50 - 120.00     44.00 - 44.50       .000   .000       .00      2.446   .074    81.81 *
*    4010    119.50 - 120.00     44.50 - 45.00      2.423   .000     84.73      2.446   .074    74.18 *
*    4011    119.50 - 120.00     45.00 - 45.50      3.418   .432     86.84      2.446   .074    81.81 *
*    4012    119.50 - 120.00     45.50 - 46.00      3.539   .322     63.92      2.446   .074   101.31 *
*    4013    119.50 - 120.00     46.00 - 46.50      3.623   .239     45.64      2.296   .225    69.72 *
*    4014    119.50 - 120.00     46.50 - 47.00      3.790   .141     28.04      2.296   .225    35.92 *
*    4015    119.50 - 120.00     47.00 - 47.50      3.856   .115     58.20      2.446   .074    11.63 *
*    4016    119.50 - 120.00     47.50 - 48.00      3.758   .125     42.53      2.446   .074    36.00 *
*    4017    119.50   120.00     48.00 - 48.50      3.721   .115     24.96      2.446   .074    34.34 *
*    4018    119.50 . 120.00     48.50 - 49.00      3.648   .203     56.76      2.071   .000    42.64 *
*    4019    119.50 - 120.00     49.00 - 49.50      3.383   .245     72.82      2.071   .000    73.41 *
*    4020    119.50 - 120.00     49.50 - 50.00      3.074   .328     97.56      3.821   .363    95.65 *
*    4021    120.00 - 120.50     33.00 - 33.50      4.986   .376    149.33      4.776   .162   108.09 *
*    4022    120.00 - 120.50     33.50 - 34.00      5.074   .389    116.49      4.812   .175    78.51 *
*    4023    120.00 - 120.50     34.00 - 34.50      5.114   .366     63.51      4.875   .141    68.52 *
*    4024    120.00 - 120.50     34.50 - 35.00      5.181   .354     94.89      4.887   .143    70.51 *
*    4025    120.00 - 120.50     35.00 - 35.50      5.226   .382    104.04      4.861   .171    82.88 *
*                                                                                                     *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
4026	120.00 - 120.50	35.50 - 36.00	5.273	.385	86.99	4.857	.177	48.02
4027	120.00 - 120.50	36.00 - 36.50	5.408	.387	124.23	4.878	.180	54.35
4028	120.00 - 120.50	36.50 - 37.00	5.426	.377	134.76	4.878	.180	89.28
4029	120.00 - 120.50	37.00 - 37.50	5.402	.386	109.66	4.862	.178	103.35
4030	120.00 - 120.50	37.50 - 38.00	5.377	.405	145.25	4.719	.216	99.09
4031	120.00 - 120.50	38.00 - 38.50	5.348	.406	144.47	4.644	.238	90.40
4032	120.00 - 120.50	38.50 - 39.00	5.252	.363	119.79	4.631	.229	69.87
4033	120.00 - 120.50	39.00 - 39.50	5.235	.367	66.30	4.622	.222	26.09
4034	120.00 - 120.50	39.50 - 40.00	5.216	.377	48.11	4.608	.211	40.90
4035	120.00 - 120.50	40.00 - 40.50	5.120	.364	80.14	4.562	.183	83.03
4036	120.00 - 120.50	40.50 - 41.00	5.070	.395	95.58	4.384	.295	64.67
4037	120.00 - 120.50	41.00 - 41.50	4.966	.430	127.19	4.338	.268	95.70
4038	120.00 - 120.50	41.50 - 42.00	4.825	.403	154.08	4.291	.247	77.14
4039	120.00 - 120.50	42.00 - 42.50	2.423	.000	27.43	3.627	.148	27.68
4040	120.00 - 120.50	42.50 - 43.00	2.423	.000	44.07	3.627	.148	44.35
4041	120.00 - 120.50	43.00 - 43.50	2.423	.000	74.25	3.627	.148	74.35
4042	120.00 - 120.50	43.50 - 44.00	.000	.000	.00	.000	.000	.00
4043	120.00 - 120.50	44.00 - 44.50	.000	.000	.00	.000	.000	.00
4044	120.00 - 120.50	44.50 - 45.00	2.423	.000	100.38	.000	.000	.00
4045	120.00 - 120.50	45.00 - 45.50	2.928	.328	82.21	.000	.000	.00
4046	120.00 - 120.50	45.50 - 46.00	3.373	.054	70.85	2.296	.225	99.45
4047	120.00 - 120.50	46.00 - 46.50	3.661	.018	59.92	2.597	.225	76.33
4048	120.00 - 120.50	46.50 - 47.00	3.850	.054	49.85	2.773	.225	58.90
4049	120.00 - 120.50	47.00 - 47.50	3.944	.105	50.99	2.839	.163	40.83
4050	120.00 - 120.50	47.50 - 48.00	3.961	.119	25.66	2.986	.137	63.87
4051	120.00 - 120.50	48.00 - 48.50	3.904	.109	28.53	2.884	.114	67.06
4052	120.00 - 120.50	48.50 - 49.00	3.747	.174	52.43	2.747	.074	70.03
4053	120.00 - 120.50	49.00 - 49.50	3.503	.189	65.70	2.534	.014	73.77
4054	120.00 - 120.50	49.50 - 50.00	3.074	.328	83.25	2.446	.074	97.56
4055	120.50 - 121.00	33.00 - 33.50	4.924	.392	160.52	4.706	.147	117.37
4056	120.50 - 121.00	33.50 - 34.00	5.023	.403	133.19	4.750	.161	94.88
4057	120.50 - 121.00	34.00 - 34.50	5.068	.376	83.24	4.768	.161	61.78
4058	120.50 - 121.00	34.50 - 35.00	5.144	.362	55.92	4.785	.166	56.77
4059	120.50 - 121.00	35.00 - 35.50	5.205	.396	87.31	4.734	.246	66.94
4060	120.50 - 121.00	35.50 - 36.00	5.255	.398	75.40	4.730	.258	32.12

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*                               * SEISMIC MAP OF CONTINENTAL U.S. *                              *
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*   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)        A(N)    C(N)    R(N)  *
**************************************************************************************************
*                                                                                                *
*   4C61    120.50 - 121.00    36.00 - 36.50      5.395   .399    66.65       4.768   .262    51.89  *
*   4C62    120.50 - 121.00    36.50 - 37.00      5.415   .388    91.44       4.771   .264    48.64  *
*   4C63    120.50 - 121.00    37.00 - 37.50      5.401   .390   117.24       4.805   .270    83.10  *
*   4C64    120.50 - 121.00    37.50 - 38.00      5.393   .398   131.95       4.760   .205    96.81  *
*   4C65    120.50 - 121.00    38.00 - 38.50      5.379   .395   137.63       4.652   .295    93.73  *
*   4C66    120.50 - 121.00    38.50 - 39.00      5.289   .352   129.90       4.638   .286    83.93  *
*   4C67    120.50 - 121.00    39.00 - 39.50      5.275   .354   113.58       4.629   .280    64.42  *
*   4C68    120.50 - 121.00    39.50 - 40.00      5.258   .362    89.83       4.610   .269    73.80  *
*   4C69    120.50 - 121.00    40.00 - 40.50      5.169   .349   109.68       4.550   .234    59.47  *
*   4C70    120.50 - 121.00    40.50 - 41.00      5.127   .375    64.86       4.519   .224    94.64  *
*   4C71    120.50 - 121.00    41.00 - 41.50      5.039   .401   138.33       4.481   .204   111.46  *
*   4C72    120.50 - 121.00    41.50 - 42.00      4.922   .382   163.45       4.445   .190   109.02  *
*   4C73    120.50 - 121.00    42.00 - 42.50      2.423   .000    10.00       3.627   .148    51.55  *
*   4C74    120.50 - 121.00    42.50 - 43.00      2.423   .000    35.92       3.627   .148    61.85  *
*   4C75    120.50 - 121.00    43.00 - 43.50      2.423   .000    69.72       3.627   .148    85.60  *
*   4C76    120.50 - 121.00    43.50 - 44.00       .000   .000      .00        .000   .000      .00  *
*   4C77    120.50 - 121.00    44.00 - 44.50       .000   .000      .00        .000   .000      .00  *
*   4C78    120.50 - 121.00    44.50 - 45.00      2.423   .000   100.38        .000   .000      .00  *
*   4C79    120.50 - 121.00    45.00 - 45.50      2.928   .328    91.39       2.296   .225    99.92  *
*   4C80    120.50 - 121.00    45.50 - 46.00      3.421   .028    73.46       2.597   .225    82.07  *
*   4C81    120.50 - 121.00    46.00 - 46.50      3.784   .073    61.27       3.593   .705    98.68  *
*   4C82    120.50 - 121.00    46.50 - 47.00      3.996   .109    38.61       3.722   .588    85.59  *
*   4C83    120.50 - 121.00    47.00 - 47.50      4.082   .178    42.11       3.729   .579    77.37  *
*   4C84    120.50 - 121.00    47.50 - 48.00      4.103   .196    28.69       3.736   .571    81.47  *
*   4C85    120.50 - 121.00    48.00 - 48.50      4.059   .180    43.64       3.721   .584    93.94  *
*   4C86    120.50 - 121.00    48.50 - 49.00      3.891   .225    43.54       3.036   .132    65.94  *
*   4C87    120.50 - 121.00    49.00 - 49.50      3.620   .244    56.73       2.534   .014    60.09  *
*   4C88    120.50 - 121.00    49.50 - 50.00      3.217   .272    77.31       2.446   .074    83.25  *
*   4C89    121.00 - 121.50    34.00 - 34.50      5.048   .382   123.90       4.668   .223    57.22  *
*   4C90    121.00 - 121.50    34.50 - 35.00      5.127   .367   103.65       4.688   .234    23.64  *
*   4C91    121.00 - 121.50    35.00 - 35.50      5.190   .401    70.25       4.704   .242    58.17  *
*   4C92    121.00 - 121.50    35.50 - 36.00      5.242   .403    90.10       4.718   .249    59.70  *
*   4C93    121.00 - 121.50    36.00 - 36.50      5.382   .404    68.05       4.757   .253    48.15  *
*   4C94    121.00 - 121.50    36.50 - 37.00      5.405   .391    51.23       4.760   .256    28.12  *
*   4C95    121.00 - 121.50    37.00 - 37.50      5.397   .392    80.13       4.822   .279    66.46  *
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                          * SEISMIC MAP OF CONTINENTAL U.S. *
  GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)   C(H)    R(H)       A(N)   C(N)    R(N)

  4096   121.00 - 121.50   37.50 - 38.00    5.400   .392   105.97     4.817   .193    79.76
  4097   121.00 - 121.50   38.00 - 38.50    5.390   .390   100.44     4.732   .254    91.75
  4098   121.00 - 121.50   38.50 - 39.00    5.301   .346   123.47     4.722   .249   100.69
  4099   121.00 - 121.50   39.00 - 39.50    5.288   .348   124.10     4.714   .244    96.32
  4100   121.00 - 121.50   39.50 - 40.00    5.276   .356    67.68     4.699   .236    92.25
  4101   121.00 - 121.50   40.00 - 40.50    5.189   .343   118.8      4.647   .208    70.10
  4102   121.00 - 121.50   40.50 - 41.00    5.149   .367   120.90     4.622   .201    77.26
  4103   121.00 - 121.50   41.00 - 41.50    5.067   .389   151.18     4.590   .189   118.51
  4104   121.00 - 121.50   41.50 - 42.00    4.958   .374   171.42     4.563   .180   129.39
  4105   121.00 - 121.50   42.00 - 42.50    2.724   .000    35.83     3.637   .148    65.64
  4106   121.00 - 121.50   42.50 - 43.00    2.724   .000    54.71     3.627   .148    78.70
  4107   121.00 - 121.50   43.00 - 43.50    2.724   .000    85.07     3.627   .148   100.36
  4108   121.00 - 121.50   43.50 - 44.00     .000   .000      .00      .000   .000      .00
  4109   121.00 - 121.50   44.00 - 44.50     .000   .000      .00      .000   .000      .00
  4110   121.00 - 121.50   44.50 - 45.00    3.223   .101    95.24     2.746   .503   100.38
  4111   121.00 - 121.50   45.00 - 45.50    3.223   .101    74.36     2.896   .375    83.14
  4112   121.00 - 121.50   45.50 - 46.00    3.612   .013    70.62     2.984   .309    69.89
  4113   121.00 - 121.50   46.00 - 46.50    3.936   .047    59.57     3.718   .621    85.48
  4114   121.00 - 121.50   46.50 - 47.00    4.070   .103    42.41     3.824   .520    67.46
  4115   121.00 - 121.50   47.00 - 47.50    4.122   .159    22.62     3.761   .552    57.10
  4116   121.00 - 121.50   47.50 - 48.00    4.171   .169    31.06     3.776   .539    59.37
  4117   121.00 - 121.50   48.00 - 48.50    4.188   .160    33.20     3.766   .546    75.19
  4118   121.00 - 121.50   48.50 - 49.00    4.082   .177    26.12     3.155   .194    44.21
  4119   121.00 - 121.50   49.00 - 49.50    3.902   .170    58.69     2.884   .114    58.51
  4120   121.00 - 121.50   49.50 - 50.00    3.603   .258    78.14     2.685   .137    81.37
  4121   121.50 - 122.00   34.00 - 34.50    5.033   .392   141.73     4.625   .203    43.11
  4122   121.50 - 122.00   34.50 - 35.00    5.115   .375    70.58     4.648   .215    39.68
  4123   121.50 - 122.00   35.00 - 35.50    5.178   .409   121.63     4.665   .223    72.63
  4124   121.50 - 122.00   35.50 - 36.00    5.207   .398   117.17     4.676   .229    79.68
  4125   121.50 - 122.00   36.00 - 36.50    5.352   .400   103.40     4.722   .236    60.54
  4126   121.50 - 122.00   36.50 - 37.00    5.376   .386    49.60     4.724   .237    30.43
  4127   121.50 - 122.00   37.00 - 37.50    5.371   .384    43.18     4.808   .271    37.01
  4128   121.50 - 122.00   37.50 - 38.00    5.370   .374    64.93     4.837   .196    39.24
  4129   121.50 - 122.00   38.00 - 38.50    5.361   .370    88.26     4.758   .255    66.63
  4130   121.50 - 122.00   38.50 - 39.00    5.266   .317    98.61     4.752   .253   102.34
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*                              * SEISMIC MAP OF CONTINENTAL U.S. *
*   GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)    R(N)   *
*
*   4131   121.50 - 122.00   39.00 - 39.50      5.252   .319   117.53       4.750   .253    97.49   *
*   4132   121.50 - 122.00   39.50 - 40.00      5.240   .326   116.54       4.738   .247    64.14   *
*   4133   121.50 - 122.00   40.00 - 40.50      5.150   .300    91.06       4.692   .223    76.45   *
*   4134   121.50 - 122.00   40.50 - 41.00      5.111   .321    84.78       4.672   .217    63.66   *
*   4135   121.50 - 122.00   41.00 - 41.50      5.019   .332   149.17       4.64[illegible]   .208   116.98   *
*   4136   121.50 - 122.00   41.50 - 42.00      4.870   .286   158.99       4.621   .199   132.02   *
*   4137   121.50 - 122.00   42.00 - 42.50      3.027   .278    65.38       3.023   .255    20.86   *
*   4138   121.50 - 122.00   42.50 - 43.00      2.724   .000    62.44       2.296   .225    35.92   *
*   4139   121.50 - 122.00   43.00 - 43.50      2.724   .000    86.42       2.296   .225    69.72   *
*   4140   121.50 - 122.00   43.50 - 44.00      2.423   .000   101.31        .000   .000      .00   *
*   4141   121.50 - 122.00   44.00 - 44.50      3.112   .212    94.99        .000   .000      .00   *
*   4142   121.50 - 122.00   44.50 - 45.00      3.475   .149    80.25       2.746   .503    84.73   *
*   4143   121.50 - 122.00   45.00 - 45.50      3.475   .149    61.33       2.896   .375    64.02   *
*   4144   121.50 - 122.00   45.50 - 46.00      3.688   .034    54.01       2.984   .309    50.38   *
*   4145   121.50 - 122.00   46.00 - 46.50      4.024   .053    54.80       3.693   .648    64.38   *
*   4146   121.50 - 122.00   46.50 - 47.00      4.131   .123    26.44       3.811   .533    37.96   *
*   4147   121.50 - 122.00   47.00 - 47.50      4.181   .176    22.69       3.749   .561    33.02   *
*   4148   121.50 - 122.00   47.50 - 48.00      4.227   .194    30.04       3.776   .539    33.10   *
*   4149   121.50 - 122.00   48.00 - 48.50      4.247   .193    28.28       3.766   .546    60.51   *
*   4150   121.50 - 122.00   48.50 - 49.00      4.125   .200    42.70       3.186   .212    20.53   *
*   4151   121.50 - 122.00   49.00 - 49.50      3.937   .184    54.87       2.986   .137    51.88   *
*   4152   121.50 - 122.00   49.50 - 50.00      3.650   .242    69.01       2.835   .163    79.81   *
*   4153   122.00 - 122.50   34.00 - 34.50      4.941   .365   158.26       4.602   .167    63.11   *
*   4154   122.00 - 122.50   34.50 - 35.00      5.038   .348   135.52       4.625   .176    80.05   *
*   4155   122.00 - 122.50   35.00 - 35.50      5.107   .395   141.30       4.643   .179    93.02   *
*   4156   122.00 - 122.50   35.50 - 36.00      5.141   .382   109.44       4.655   .184    94.72   *
*   4157   122.00 - 122.50   36.00 - 36.50      5.269   .369   113.60       4.711   .172    80.68   *
*   4158   122.00 - 122.50   36.50 - 37.00      5.293   .357    61.93       4.715   .173    43.94   *
*   4159   122.00 - 122.50   37.00 - 37.50      5.303   .346    47.66       4.876   .177    70.37   *
*   4160   122.00 - 122.50   37.50 - 38.00      5.301   .331    32.56       4.849   .186    61.49   *
*   4161   122.00 - 122.50   38.00 - 38.50      5.295   .327    43.22       4.790   .224    87.26   *
*   4162   122.00 - 122.50   38.50 - 39.00      5.163   .249    51.20       4.794   .229   100.01   *
*   4163   122.00 - 122.50   39.00 - 39.50      5.152   .248    95.00       4.798   .232    66.19   *
*   4164   122.00 - 122.50   39.50 - 40.00      5.139   .252    88.77       4.788   .228    62.64   *
*   4165   122.00 - 122.50   40.00 - 40.50      5.108   .273   124.74       4.749   .213    79.34   *
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* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
4166	122.00 - 122.50	40.50 - 41.00	5.069	.290	131.64	4.730	.209	101.88
4167	122.00 - 122.50	41.00 - 41.50	4.955	.300	142.35	4.712	.205	115.05
4168	122.00 - 122.50	41.50 - 42.00	4.823	.292	145.57	4.698	.201	132.51
4169	122.00 - 122.50	42.00 - 42.50	3.027	.278	46.24	3.199	.255	56.69
4170	122.00 - 122.50	42.50 - 43.00	2.724	.000	54.71	2.839	.206	66.48
4171	122.00 - 122.50	43.00 - 43.50	2.724	.000	85.07	2.298	.225	74.25
4172	122.00 - 122.50	43.50 - 44.00	2.423	.000	85.22	.000	.000	.00
4173	122.00 - 122.50	44.00 - 44.50	3.262	.238	82.03	.000	.000	.00
4174	122.00 - 122.50	44.50 - 45.00	3.549	.172	66.24	2.746	.503	73.76
4175	122.00 - 122.50	45.00 - 45.50	3.549	.172	46.86	2.696	.375	47.93
4176	122.00 - 122.50	45.50 - 46.00	3.740	.061	29.34	2.984	.309	30.60
4177	122.00 - 122.50	46.00 - 46.50	4.036	.067	51.25	3.693	.648	37.06
4178	122.00 - 122.50	46.50 - 47.00	4.100	.133	27.02	3.811	.533	46.20
4179	122.00 - 122.50	47.00 - 47.50	4.147	.183	20.23	3.754	.555	13.88
4180	122.00 - 122.50	47.50 - 48.00	4.211	.206	21.75	3.781	.535	23.19
4181	122.00 - 122.50	48.00 - 48.50	4.237	.194	25.74	3.770	.542	51.50
4182	122.00 - 122.50	48.50 - 49.00	4.092	.236	30.53	3.199	.209	35.28
4183	122.00 - 122.50	49.00 - 49.50	3.965	.181	42.38	3.019	.103	51.63
4184	122.00 - 122.50	49.50 - 50.00	3.741	.205	60.72	2.835	.163	76.30
4185	122.50 - 123.00	34.00 - 34.50	4.862	.414	182.68	4.569	.158	110.67
4186	122.50 - 123.00	34.50 - 35.00	4.961	.398	167.20	4.539	.166	110.07
4187	122.50 - 123.00	35.00 - 35.50	5.036	.443	158.73	4.608	.171	113.53
4188	122.50 - 123.00	35.50 - 36.00	5.076	.428	140.04	4.619	.176	108.83
4189	122.50 - 123.00	36.00 - 36.50	5.198	.412	129.64	4.678	.166	77.62
4190	122.50 - 123.00	36.50 - 37.00	5.222	.395	100.84	4.679	.167	85.72
4191	122.50 - 123.00	37.00 - 37.50	5.237	.379	77.72	4.861	.180	105.55
4192	122.50 - 123.00	37.50 - 38.00	5.248	.357	37.62	4.841	.193	100.47
4193	122.50 - 123.00	38.00 - 38.50	5.252	.349	62.84	4.783	.228	53.31
4194	122.50 - 123.00	38.50 - 39.00	5.133	.254	37.47	4.798	.237	71.34
4195	122.50 - 123.00	39.00 - 39.50	5.121	.252	71.03	4.836	.221	82.52
4196	122.50 - 123.00	39.50 - 40.00	5.109	.256	110.48	4.872	.195	99.42
4197	122.50 - 123.00	40.00 - 40.50	5.075	.277	127.31	4.848	.190	77.30
4198	122.50 - 123.00	40.50 - 41.00	5.033	.295	130.76	4.840	.189	105.03
4199	122.50 - 123.00	41.00 - 41.50	4.926	.293	123.72	4.828	.187	89.34
4200	122.50 - 123.00	41.50 - 42.00	4.773	.270	125.09	4.817	.185	128.97

* SEISMIC MAP OF CONTINENTAL U.S. *

GFID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
4201	122.50 - 123.00	42.00 - 42.50	3.969	.502	45.78	3.196	.255	65.49
4202	122.50 - 123.00	42.50 - 43.00	2.928	.328	53.03	2.839	.206	75.53
4203	122.50 - 123.00	43.00 - 43.50	2.928	.328	87.08	2.296	.225	86.43
4204	122.50 - 123.00	43.50 - 44.00	2.423	.000	73.90	.000	.000	.00
4205	122.50 - 123.00	44.00 - 44.50	3.262	.238	66.51	.000	.000	.00
4206	122.50 - 123.00	44.50 - 45.00	3.549	.172	48.89	2.746	.503	69.72
4207	122.50 - 123.00	45.00 - 45.50	3.549	.172	33.18	2.896	.375	40.64
4208	122.50 - 123.00	45.50 - 46.00	3.773	.095	17.93	2.984	.309	12.68
4209	122.50 - 123.00	46.00 - 46.50	4.053	.092	52.07	3.693	.648	59.52
4210	122.50 - 123.00	46.50 - 47.00	4.105	.142	34.42	3.811	.533	55.27
4211	122.50 - 123.00	47.00 - 47.50	4.157	.196	20.34	3.754	.555	29.71
4212	122.50 - 123.00	47.50 - 48.00	4.219	.217	27.25	3.781	.535	32.67
4213	122.50 - 123.00	48.00 - 48.50	4.242	.199	25.90	3.770	.542	33.93
4214	122.50 - 123.00	48.50 - 49.00	4.092	.236	27.49	3.199	.209	22.27
4215	122.50 - 123.00	49.00 - 49.50	3.980	.189	21.73	3.019	.103	49.48
4216	122.50 - 123.00	49.50 - 50.00	3.741	.205	54.[illegible]1	2.954	.145	76.75
4217	123.00 - 123.50	36.00 - 36.50	5.081	.326	140.01	4.622	.177	117.48
4218	123.00 - 123.50	36.50 - 37.00	5.105	.312	117.62	4.642	.181	114.99
4219	123.00 - 123.50	37.00 - 37.50	5.121	.294	94.94	4.843	.193	132.74
4220	123.00 - 123.50	37.50 - 38.00	5.132	.267	73.55	4.843	.195	125.71
4221	123.00 - 123.50	38.00 - 38.50	5.135	.258	46.28	4.787	.229	102.97
4222	123.00 - 123.50	38.50 - 39.00	5.128	.258	59.10	4.815	.244	77.68
4223	123.00 - 123.50	39.00 - 39.50	5.117	.256	54.07	4.8[illegible]	.229	68.90
4224	123.00 - 123.50	39.50 - 40.00	5.104	.260	109.19	4.907	.193	89.36
4225	123.00 - 123.50	40.00 - 40.50	5.070	.283	118.44	4.902	.194	74.18
4226	123.00 - 123.50	40.50 - 41.00	5.027	.302	111.65	4.820	.282	83.27
4227	123.00 - 123.50	41.00 - 41.50	4.918	.301	75.26	4.811	.279	63.53
4228	123.00 - 123.50	41.50 - 42.00	4.764	.275	107.60	4.806	.276	105.93
4229	123.00 - 123.50	42.00 - 42.50	4.041	.467	81.59	3.388	.225	64.93
4230	123.00 - 123.50	42.50 - 43.00	2.928	.328	53.76	2.922	.187	73.39
4231	123.00 - 123.50	43.00 - 43.50	2.928	.328	81.03	2.597	.225	92.19
4232	123.00 - 123.50	43.50 - 44.00	2.423	.000	69.72	2.296	.225	103.14
4233	123.00 - 123.50	44.00 - 44.50	3.262	.238	58.65	.000	.000	.00
4234	123.00 - 123.50	44.50 - 45.00	3.549	.172	27.58	2.746	.503	73.76
4235	123.00 - 123.50	45.00 - 45.50	3.549	.172	16.24	2.896	.375	48.76

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
4236	123.00 - 123.50	45.50 - 46.00	3.773	.095	38.71	2.984	.309	32.25
4237	123.00 - 123.50	46.00 - 46.50	4.036	.099	58.65	3.693	.648	76.07
4238	123.00 - 123.50	46.50 - 47.00	4.084	.133	45.40	3.811	.533	72.86
4239	123.00 - 123.50	47.00 - 47.50	4.136	.181	20.58	3.754	.555	55.06
4240	123.00 - 123.50	47.50 - 48.00	4.169	.214	26.43	3.781	.535	56.37
4241	123.00 - 123.50	48.00 - 48.50	4.197	.185	27.08	3.770	.542	57.03
4242	123.00 - 123.50	48.50 - 49.00	4.000	.272	26.95	3.199	.209	22.69
4243	123.00 - 123.50	49.00 - 49.50	3.888	.208	38.67	3.019	.103	51.51
4244	123.00 - 123.50	49.50 - 50.00	3.627	.179	54.43	2.954	.145	76.31
4245	123.50 - 124.00	36.00 - 36.50	5.056	.337	160.71	4.532	.183	135.65
4246	123.50 - 124.00	36.50 - 37.00	5.060	.324	140.69	4.557	.189	132.90
4247	123.50 - 124.00	37.00 - 37.50	5.099	.303	121.85	4.795	.203	150.63
4248	123.50 - 124.00	37.50 - 38.00	5.117	.271	106.09	4.846	.197	146.99
4249	123.50 - 124.00	38.00 - 38.50	5.123	.260	93.35	4.792	.233	126.13
4250	123.50 - 124.00	38.50 - 39.00	5.117	.260	96.43	4.852	.226	113.43
4251	123.50 - 124.00	39.00 - 39.50	5.105	.259	77.13	4.870	.216	90.90
4252	123.50 - 124.00	39.50 - 40.00	5.091	.264	108.53	4.915	.193	84.13
4253	123.50 - 124.00	40.00 - 40.50	5.055	.288	93.64	4.926	.194	51.03
4254	123.50 - 124.00	40.50 - 41.00	5.010	.309	78.09	4.864	.301	53.95
4255	123.50 - 124.00	41.00 - 41.50	4.897	.309	69.44	4.857	.299	85.72
4256	123.50 - 124.00	41.50 - 42.00	4.732	.272	86.76	4.852	.297	71.81
4257	123.50 - 124.00	42.00 - 42.50	4.074	.432	70.29	3.601	.212	64.28
4258	123.50 - 124.00	42.50 - 43.00	2.928	.328	47.16	3.299	.194	75.22
4259	123.50 - 124.00	43.00 - 43.50	2.928	.328	76.38	3.017	.154	78.81
4260	123.50 - 124.00	43.50 - 44.00	2.423	.000	73.90	2.685	.137	80.22
4261	123.50 - 124.00	44.00 - 44.50	3.262	.238	63.92	2.446	.074	88.70
4262	123.50 - 124.00	44.50 - 45.00	3.549	.172	46.43	2.821	.411	86.36
4263	123.50 - 124.00	45.00 - 45.50	3.549	.172	20.75	2.896	.375	66.80
4264	123.50 - 124.00	45.50 - 46.00	3.685	.116	50.14	2.896	.375	54.56
4265	123.50 - 124.00	46.00 - 46.50	3.959	.109	64.42	3.661	.685	95.93
4266	123.50 - 124.00	46.50 - 47.00	4.006	.132	49.00	3.782	.563	93.66
4267	123.50 - 124.00	47.00 - 47.50	4.054	.177	37.86	3.727	.576	79.06
4268	123.50 - 124.00	47.50 - 48.00	4.101	.220	40.76	3.742	.565	75.91
4269	123.50 - 124.00	48.00 - 48.50	4.150	.179	35.80	3.742	.565	47.84
4270	123.50 - 124.00	48.50 - 49.00	4.026	.186	23.32	3.121	.175	43.15

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
4271	123.50 - 124.00	49.00 - 49.50	3.948	.161	51.64	2.884	.114	57.00
4272	123.50 - 124.00	49.50 - 50.00	3.802	.206	69.66	2.839	.206	73.77
4273	124.00 - 124.50	38.00 - 38.50	5.099	.266	127.13	4.737	.257	130.55
4274	124.00 - 124.50	38.50 - 39.00	5.092	.266	120.62	4.804	.244	[illegible]
4275	124.00 - 124.50	39.00 - 39.50	5.087	.266	76.56	4.832	.227	97.65
4276	124.00 - 124.50	39.50 - 40.00	5.072	.271	105.15	4.887	.197	69.47
4277	124.00 - 124.50	40.00 - 40.50	5.033	.299	49.69	4.902	.198	27.92
4278	124.00 - 124.50	40.50 - 41.00	4.986	.320	36.03	4.950	.194	50.14
4279	124.00 - 124.50	41.00 - 41.50	4.867	.322	29.50	4.949	.193	84.05
4280	124.00 - 124.50	41.50 - 42.00	4.687	.273	71.18	4.941	.192	101.72
4281	124.00 - 124.50	42.00 - 42.50	4.153	.472	38.15	3.874	.225	67.33
4282	124.00 - 124.50	42.50 - 43.00	2.928	.328	40.55	3.651	.242	[illegible]
4283	124.00 - 124.50	43.00 - 43.50	2.928	.328	75.17	3.477	.160	[illegible]
4284	124.00 - 124.50	43.50 - 44.00	2.423	.000	85.22	3.055	.117	66.16
4285	124.00 - 124.50	44.00 - 44.50	3.262	.238	76.07	3.007	.088	83.12
4286	124.00 - 124.50	44.50 - 45.00	3.524	.198	62.92	2.865	.367	94.55
4287	124.00 - 124.50	45.00 - 45.50	3.524	.198	46.17	2.746	.503	80.66
4288	124.00 - 124.50	45.50 - 46.00	3.612	.189	62.89	2.746	.503	72.91
4289	124.00 - 124.50	46.00 - 46.50	3.885	.155	69.97	2.821	.411	82.38
4290	124.00 - 124.50	46.50 - 47.00	3.898	.136	30.54	2.940	.316	95.88
4291	124.00 - 124.50	47.00 - 47.50	3.945	.144	30.52	2.796	.026	76.99
4292	124.00 - 124.50	47.50 - 48.00	4.008	.172	37.79	3.019	.103	68.62
4293	124.00 - 124.50	48.00 - 48.50	4.065	.150	32.74	3.019	.103	50.94
4294	124.00 - 124.50	48.50 - 49.00	3.953	.155	43.14	2.986	.137	60.00
4295	124.00 - 124.50	49.00 - 49.50	3.901	.156	58.34	2.884	.114	72.95
4296	124.00 - 124.50	49.50 - 50.00	3.776	.217	66.89	2.839	.206	76.67
4297	124.50 - 125.00	38.00 - 38.50	5.079	.275	153.48	4.710	.252	136.65
4298	124.50 - 125.00	38.50 - 39.00	5.072	.274	143.47	4.784	.241	118.67
4299	124.50 - 125.00	39.00 - 39.50	5.072	.275	127.45	4.829	.227	97.03
4300	124.50 - 125.00	39.50 - 40.00	5.065	.277	110.33	4.886	.198	65.38
4301	124.50 - 125.00	40.00 - 40.50	5.027	.305	55.09	4.904	.198	25.56
4302	124.50 - 125.00	40.50 - 41.00	4.978	.328	34.55	4.958	.196	42.99
4303	124.50 - 125.00	41.00 - 41.50	4.857	.332	48.42	4.958	.195	60.98
4304	124.50 - 125.00	41.50 - 42.00	4.672	.282	76.22	4.954	.193	91.89
4305	124.50 - 125.00	42.00 - 42.50	4.142	.491	74.45	4.278	.206	64.04

* SEISMIC MAP OF CONTINENTAL U.S. *

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
4306	124.50 - 125.00	42.50 - 43.00	2.783	.490	44.07	4.237	.209	53.86
4307	124.50 - 125.00	43.00 - 43.50	2.783	.490	74.25	4.151	.216	71.89
4308	124.50 - 125.00	43.50 - 44.00	2.423	.000	101.31	3.963	.198	75.30
4309	124.50 - 125.00	44.00 - 44.50	3.262	.238	91.62	3.637	.193	80.21
4310	124.50 - 125.00	44.50 - 45.00	3.262	.238	71.84	3.199	.123	93.67
4311	124.50 - 125.00	45.00 - 45.50	3.262	.238	63.47	2.296	.225	80.66
4312	124.50 - 125.00	45.50 - 46.00	3.373	.252	74.07	2.296	.225	72.91
4313	124.50 - 125.00	46.00 - 46.50	3.577	.231	69.51	2.296	.225	80.65
4314	124.50 - 125.00	46.50 - 47.00	3.557	.203	46.66	2.296	.225	100.38
4315	124.50 - 125.00	47.00 - 47.50	3.667	.256	46.22	2.621	.255	90.44
4316	124.50 - 125.00	47.50 - 48.00	3.758	.316	48.63	2.981	.245	80.93
4317	124.50 - 125.00	48.00 - 48.50	3.740	.303	30.69	2.981	.245	67.19
4318	124.50 - 125.00	48.50 - 49.00	3.731	.269	44.31	2.981	.245	69.04
4319	124.50 - 125.00	49.00 - 49.50	3.679	.266	52.29	2.981	.245	82.54
4320	124.50 - 125.00	49.50 - 50.00	3.554	.307	37.60	2.939	.298	85.62
4321	125.00 - 125.50	40.00 - 40.50	5.015	.312	64.41	4.902	.199	31.79
4322	125.00 - 125.50	40.50 - 41.00	4.967	.333	44.84	4.959	.197	37.22
4323	125.00 - 125.50	41.00 - 41.50	4.843	.339	58.68	4.980	.202	60.03
4324	125.00 - 125.50	41.50 - 42.00	4.653	.283	86.61	4.978	.200	70.09
4325	125.00 - 125.50	42.00 - 42.50	4.117	.504	93.99	4.437	.210	40.26
4326	125.00 - 125.50	42.50 - 43.00	2.783	.490	62.44	4.453	.203	60.62
4327	125.00 - 125.50	43.00 - 43.50	2.783	.490	86.43	4.380	.202	51.27
4328	125.00 - 125.50	43.50 - 44.00	.000	.000	.00	4.279	.200	57.08
4329	125.00 - 125.50	44.00 - 44.50	2.723	.300	100.85	4.092	.200	75.33
4330	125.00 - 125.50	44.50 - 45.00	2.723	.300	81.24	3.816	.269	93.36
4331	125.00 - 125.50	45.00 - 45.50	2.723	.300	73.55	2.296	.225	60.07
4332	125.00 - 125.50	45.50 - 46.00	3.024	.300	82.69	2.296	.225	49.17
4333	125.00 - 125.50	46.00 - 46.50	3.200	.300	75.22	2.296	.225	60.07
4334	125.00 - 125.50	46.50 - 47.00	3.112	.212	55.65	2.296	.225	84.73
4335	125.00 - 125.50	47.00 - 47.50	3.351	.149	60.48	2.881	.298	89.81
4336	125.00 - 125.50	47.50 - 48.00	3.612	.189	65.72	3.040	.318	70.46
4337	125.00 - 125.50	48.00 - 48.50	3.549	.172	47.73	3.040	.318	56.52
4338	125.00 - 125.50	48.50 - 49.00	3.613	.244	23.78	3.040	.318	57.83
4339	125.00 - 125.50	49.00 - 49.50	3.601	.255	47.01	3.040	.318	74.92
4340	125.00 - 125.50	49.50 - 50.00	3.528	.300	15.69	2.822	.367	82.75

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*                      * SEISMIC MAP OF CONTINENTAL U.S. *                     *
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*  GRID   LONG1 - LONG2     LAT1 - LAT2      A(H)   C(H)   R(H)      A(N)   C(N)   R(N)   *
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*
*  4341   125.50 - 126.00   40.00 - 40.50    4.978  .344   62.30     4.876  .203   31.15  *
*  4342   125.50 - 126.00   40.50 - 41.00    4.957  .344   75.32     4.950  .199   45.65  *
*  4343   125.50 - 126.00   41.00 - 41.50    4.836  .346   59.87     4.988  .207   52.46  *
*  4344   125.50 - 126.00   41.50 - 42.00    4.642  .290   98.90     4.994  .204   50.49  *
*  4345   125.50 - 126.00   42.00 - 42.50    4.[illegible]17  .504  110.76     4.522  .227   34.66  *
*  4346   125.50 - 126.00   42.50 - 43.00    2.783  .490   84.61     4.573  .243   47.61  *
*  4347   125.50 - 126.00   43.00 - 43.50    2.783  .490  103.59     4.492  .227   37.01  *
*  4348   125.50 - 126.00   43.50 - 44.00     .000  .000     .00     4.420  .220   48.22  *
*  4349   125.50 - 126.00   44.00 - 44.50     .000  .000     .00     4.316  .182   66.82  *
*  4350   125.50 - 126.00   44.50 - 45.00     .000  .000     .00     4.130  .199   87.75  *
*  4351   125.50 - 126.00   45.00 - 45.50     .000  .000     .00     2.987  .184   65.23  *
*  4352   125.50 - 126.00   45.50 - 46.00    2.723  .300   99.45     2.839  .206   40.98  *
*  4353   125.50 - 126.00   46.00 - 46.50    3.024  .300   87.52     2.839  .206   60.26  *
*  4354   125.50 - 126.00   46.50 - 47.00    3.112  .212   77.53     2.881  .147   87.12  *
*  4355   125.50 - 126.00   47.00 - 47.50    3.311  .189   79.41     2.881  .298   77.03  *
*  4356   125.50 - 126.00   47.50 - 48.00    3.413  .212   75.27     3.114  .277   57.54  *
*  4357   125.50 - 126.00   48.00 - 48.50    3.311  .189   56.98     3.114  .277   37.10  *
*  4358   125.50 - 126.00   48.50 - 49.00    3.492  .300   46.93     3.114  .277   37.88  *
*  4359   125.50 - 126.00   49.00 - 49.50    3.471  .325   50.29     3.081  .318   60.10  *
*  4360   125.50 - 126.00   49.50 - 50.00    3.355  .414   31.07     2.939  .298   85.31  *
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SEISMICITY FOR ALASKA

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*                        *      SEISMIC MAP OF ALASKA      *                              *
*  GRID   LONG1 - LONG2     LAT1 - LAT2       A(H)   C(H)    R(H)        A(N)   C(N)    R(N)   *
*
*    1   130.00 - 130.50   52.00 - 52.50     2.762   .490    82.01      4.075   .261    51.04  *
*    2   130.00 - 130.50   52.50 - 53.00     2.762   .490   112.59      4.069   .267    86.68  *
*    3   130.00 - 130.50   53.00 - 53.50     2.762   .490   144.95      4.069   .267    94.33  *
*    4   130.00 - 130.50   53.50 - 54.00     2.762   .490   178.10      4.019   .270   125.60  *
*    5   130.00 - 130.50   54.00 - 54.50     2.762   .490   211.69      3.949   .234   130.77  *
*    6   130.00 - 130.50   54.50 - 55.00      .000   .000      .00      4.052   .307   188.49  *
*    7   130.00 - 130.50   55.00 - 55.50     2.502   .000   263.90      3.800   .274   136.67  *
*    8   130.00 - 130.50   55.50 - 56.00     2.502   .000   237.81      3.769   .296   139.26  *
*    9   130.00 - 130.50   56.00 - 56.50     2.803   .000   237.56      3.696   .341   206.32  *
*   10   130.00 - 130.50   56.50 - 57.00     2.803   .000   215.13      3.659   .378   215.28  *
*   11   130.00 - 130.50   57.00 - 57.50     2.803   .000   196.58      3.638   .400   227.27  *
*   12   130.00 - 130.50   57.50 - 58.00     2.803   .000   182.99      3.501   .445   229.97  *
*   13   130.00 - 130.50   58.00 - 58.50     2.803   .000   175.14      3.638   .430   247.72  *
*   14   130.00 - 130.50   58.50 - 59.00     2.803   .000   173.27      3.680   .387   265.36  *
*   15   130.00 - 130.50   59.00 - 59.50     2.803   .000   177.15      3.684   .376   275.83  *
*   16   130.00 - 130.50   59.50 - 60.00     2.803   .000   186.43      3.183   .187   210.35  *
*   17   130.50 - 131.00   52.00 - 52.50     2.762   .490    72.99      4.085   .258    45.46  *
*   18   130.50 - 131.00   52.50 - 53.00     2.762   .490   106.20      4.080   .264    74.01  *
*   19   130.50 - 131.00   53.00 - 53.50     2.762   .490   140.04      4.166   .322    60.61  *
*   20   130.50 - 131.00   53.50 - 54.00     2.762   .490   174.13      4.136   .324   125.26  *
*   21   130.50 - 131.00   54.00 - 54.50     2.762   .490   208.36      4.089   .304   154.30  *
*   22   130.50 - 131.00   54.50 - 55.00      .000   .000      .00      4.109   .302   180.46  *
*   23   130.50 - 131.00   55.00 - 55.50     2.502   .000   253.06      3.896   .271   177.91  *
*   24   130.50 - 131.00   55.50 - 56.00     2.502   .000   225.72      3.870   .290   186.67  *
*   25   130.50 - 131.00   56.00 - 56.50     2.803   .000   224.48      3.813   .327   190.82  *
*   26   130.50 - 131.00   56.50 - 57.00     2.803   .000   200.56      3.787   .355   198.17  *
*   27   130.50 - 131.00   57.00 - 57.50     2.803   .000   180.57      3.772   .371   209.61  *
*   28   130.50 - 131.00   57.50 - 58.00     2.803   .000   165.08      3.684   .396   218.45  *
*   29   130.50 - 131.00   58.00 - 58.50     3.201   .000   185.09      3.743   .355   233.44  *
*   30   130.50 - 131.00   58.50 - 59.00     3.201   .000   180.63      3.772   .326   251.19  *
*   31   130.50 - 131.00   59.00 - 59.50     3.201   .000   181.29      3.777   .317   264.45  *
*   32   130.50 - 131.00   59.50 - 60.00     3.201   .000   186.55      3.326   .150   216.57  *
*   33   131.00 - 131.50   52.00 - 52.50     2.762   .490    69.72      4.085   .258    37.93  *
*   34   131.00 - 131.50   52.50 - 53.00     2.762   .490   103.98      4.080   .264    54.17  *
*   35   131.00 - 131.50   53.00 - 53.50     2.762   .490   138.36      4.209   .318    92.60  *
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*                                    *     SEISMIC MAP OF ALASKA     *                                        *
*   GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)    C(H)    R(H)        A(N)    C(N)    R(N)          *
*
*    36     131.0 - 131.5      53.50 - 54.00     2.762   .490   172.79       4.181   .319   121.90         *
*    37     131.0 - 131.5      54.00 - 54.50     2.762   .490   207.24       4.140   .301   146.91         *
*    38     131.0 - 131.5      54.50 - 55.00      .000   .000      .00       4.135   .288   169.92         *
*    39     131.0 - 131.5      55.00 - 55.50     2.803   .000   257.66       3.936   .252   165.78         *
*    40     131.0 - 131.5      55.50 - 56.00     2.803   .000   230.29       3.914   .269   172.71         *
*    41     131.0 - 131.5      56.00 - 56.50     2.979   .000   217.05       3.876   .287   176.26         *
*    42     131.0 - 131.5      56.50 - 57.00     3.104   .000   205.80       3.856   .308   142.27         *
*    43     131.0 - 131.5      57.00 - 57.50     3.201   .000   194.88       3.845   .320   192.91         *
*    44     131.0 - 131.5      57.50 - 58.00     3.201   .000   177.85       3.776   .333   202.70         *
*    45     131.0 - 131.5      58.00 - 58.50     3.280   .000   171.99       3.807   .291   213.85         *
*    46     131.0 - 131.5      58.50 - 59.00     3.280   .000   168.77       3.827   .272   227.59         *
*    47     131.0 - 131.5      59.00 - 59.50     3.280   .000   170.79       3.831   .265   238.85         *
*    48     131.0 - 131.5      59.50 - 60.00     3.280   .000   177.42       3.350   .151   198.33         *
*    49     131.5 - 132.0      52.00 - 52.50     2.762   .490    72.99       4.085   .258    47.83         *
*    50     131.5 - 132.0      52.50 - 53.00     2.762   .490   106.20       4.080   .264    47.11         *
*    51     131.5 - 132.0      53.00 - 53.50     2.762   .490   140.04       4.218   .314    98.61         *
*    52     131.5 - 132.0      53.50 - 54.00     2.762   .490   174.13       4.197   .310   103.09         *
*    53     131.5 - 132.0      54.00 - 54.50     2.762   .490   208.36       4.165   .288   135.17         *
*    54     131.5 - 132.0      54.50 - 55.00     2.502   .000   277.20       4.135   .288   156.55         *
*    55     131.5 - 132.0      55.00 - 55.50     2.979   .000   249.15       3.936   .252   151.17         *
*    56     131.5 - 132.0      55.50 - 56.00     2.979   .000   222.52       3.922   .260   157.62         *
*    57     131.5 - 132.0      56.00 - 56.50     3.104   .000   206.36       3.918   .245   162.61         *
*    58     131.5 - 132.0      56.50 - 57.00     3.201   .000   192.76       3.903   .260   167.72         *
*    59     131.5 - 132.0      57.00 - 57.50     3.280   .000   180.22       3.894   .269   177.41         *
*    60     131.5 - 132.0      57.50 - 58.00     3.280   .000   163.55       3.833   .275   135.82         *
*    61     131.5 - 132.0      58.00 - 58.50     4.052   .866   213.30       3.849   .250   196.49         *
*    62     131.5 - 132.0      58.50 - 59.00     4.052   .866   210.51       3.864   .236   208.30         *
*    63     131.5 - 132.0      59.00 - 59.50     4.052   .866   214.38       3.868   .231   218.49         *
*    64     131.5 - 132.0      59.50 - 60.00     4.052   .866   224.32       3.434   .185   173.82         *
*    65     132.0 - 132.5      52.00 - 52.50     2.762   .490    82.01       4.085   .258    57.50         *
*    66     132.0 - 132.5      52.50 - 53.00     2.762   .490   112.59       4.080   .264    41.60         *
*    67     132.0 - 132.5      53.00 - 53.50     2.762   .490   144.95       4.218   .314    50.32         *
*    68     132.0 - 132.5      53.50 - 54.00     2.762   .490   178.10       4.197   .310    62.67         *
*    69     132.0 - 132.5      54.00 - 54.50     2.762   .490   211.69       4.165   .288   121.17         *
*    70     132.0 - 132.5      54.50 - 55.00     2.953   .149   266.01       4.135   .288   141.71         *
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                                   SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2      LATI - LAT2        A(L)    C(L)     R(L)         A(N)    C(N)     R(N)

   71    132.00 - 132.50    55.00 - 55.50      3.103   .001    220.70        3.936   .252    136.79
   72    132.00 - 132.50    55.50 - 56.00      4.019   .895    302.23        3.941   .239    143.73
   73    132.00 - 132.50    56.00 - 56.50      4.032   .883    271.31        3.942   .220    116.69
   74    132.00 - 132.50    56.50 - 57.00      4.043   .873    244.33        3.924   .233    151.06
   75    132.00 - 132.50    57.00 - 57.50      4.052   .866    221.09        3.929   .233    151.65
   76    132.00 - 132.50    57.50 - 58.00      4.052   .866    202.66        3.868   .242    159.62
   77    132.00 - 132.50    58.00 - 58.50      4.060   .860    171.43        3.868   .231    190.85
   78    132.00 - 132.50    58.50 - 59.00      4.060   .860    188.69        3.882   .219    172.25
   79    132.00 - 132.50    59.00 - 59.50      4.060   .860    192.97        3.885   .214    201.66
   80    132.00 - 132.50    59.50 - 60.00      4.060   .860    203.51        3.479   .201    150.81
   81    132.50 - 133.00    52.00 - 52.50      2.762   .490     95.17        4.085   .258     32.83
   82    132.50 - 133.00    52.50 - 53.00      2.762   .490    122.51        4.080   .264     43.42
   83    132.50 - 133.00    53.00 - 53.50      2.762   .490    152.79        4.218   .314     91.49
   84    132.50 - 133.00    53.50 - 54.00      2.762   .490    184.54        4.197   .310     97.56
   85    132.50 - 133.00    54.00 - 54.50      2.762   .490    217.13        4.165   .288    104.78
   86    132.50 - 133.00    54.50 - 55.00      2.953   .149    254.72        4.135   .288    123.98
   87    132.50 - 133.00    55.00 - 55.50      3.103   .001    210.91        3.936   .252    122.94
   88    132.50 - 133.00    55.50 - 56.00      4.019   .895    288.41        3.941   .239    127.75
   89    132.50 - 133.00    56.00 - 56.50      4.043   .873    256.28        3.958   .204    129.53
   90    132.50 - 133.00    56.50 - 57.00      4.052   .866    227.52        3.945   .215    133.46
   91    132.50 - 133.00    57.00 - 57.50      4.060   .860    202.41        3.945   .215    144.98
   92    132.50 - 133.00    57.50 - 58.00      4.060   .860    181.91        3.887   .223    154.35
   93    132.50 - 133.00    58.00 - 58.50      4.067   .855    169.72        3.882   .219    156.35
   94    132.50 - 133.00    58.50 - 59.00      4.067   .855    167.44        3.889   .214    177.18
   95    132.50 - 133.00    59.00 - 59.50      4.067   .855    172.21        3.892   .210    186.57
   96    132.50 - 133.00    59.50 - 60.00      4.067   .855    183.24        3.479   .201    147.34
   97    133.00 - 133.50    52.00 - 52.50      2.762   .490    111.00        4.085   .258    100.99
   98    133.00 - 133.50    52.50 - 53.00      2.762   .490    135.18        4.080   .264     31.99
   99    133.00 - 133.50    53.00 - 53.50      2.762   .490    163.11        4.218   .314    112.40
  100    133.00 - 133.50    53.50 - 54.00      2.762   .490    193.18        4.197   .310    102.93
  101    133.00 - 133.50    54.00 - 54.50      2.762   .490    224.52        4.165   .288     59.46
  102    133.00 - 133.50    54.50 - 55.00      2.953   .149    244.22        4.140   .283    104.81
  103    133.00 - 133.50    55.00 - 55.50      3.103   .001    201.92        3.943   .245    110.79
  104    133.00 - 133.50    55.50 - 56.00      4.019   .895    275.50        3.954   .225    112.57
  105    133.00 - 133.50    56.00 - 56.50      4.043   .873    242.24        3.972   .190    110.71
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*                              *      SEISMIC MAP OF ALASKA      *                                *
**************************************************************************************************
*   GRID     LONG1 - LONG2      LAT1 - LAT2         A(H)    C(H)    R(H)         A(N)    C(N)    R(N)   *
**************************************************************************************************
*                                                                                                *
*    106    133.00 - 133.50    56.50 - 57.00       4.052    .866   211.93       3.960    .200   114.93  *
*    107    133.00 - 133.50    57.00 - 57.50       4.067    .855   185.15       3.960    .200   127.97  *
*    108    133.00 - 133.50    57.50 - 58.00       4.067    .855   161.36       3.904    .207   139.72  *
*    109    133.00 - 133.50    58.00 - 58.50       4.067    .855   146.45       3.901    .212   153.93  *
*    110    133.00 - 133.50    58.50 - 59.00       4.067    .855   146.02       3.907    .207   163.65  *
*    111    133.00 - 133.50    59.00 - 59.50       4.067    .855   151.71       3.910    .202   171.78  *
*    112    133.00 - 133.50    59.50 - 60.00       4.067    .855   163.85       3.552    .158   141.03  *
*    113    133.50 - 134.00    52.00 - 52.50       2.762    .490   128.53       4.089    .258   122.02  *
*    114    133.50 - 134.00    52.50 - 53.00       2.762    .490   149.90       4.080    .264   114.28  *
*    115    133.50 - 134.00    53.00 - 53.50       2.762    .490   175.50       4.223    .309   129.30  *
*    116    133.50 - 134.00    53.50 - 54.00       2.762    .490   203.75       4.202    .305    99.22  *
*    117    133.50 - 134.00    54.00 - 54.50       2.762    .490   233.68       4.169    .283    33.33  *
*    118    133.50 - 134.00    54.50 - 55.00       2.953    .149   234.63       4.140    .283    91.94  *
*    119    133.50 - 134.00    55.00 - 55.50       3.103    .001   193.78       3.943    .245    99.84  *
*    120    133.50 - 134.00    55.50 - 56.00       4.019    .895   263.65       3.954    .225    95.87  *
*    121    133.50 - 134.00    56.00 - 56.50       4.043    .873   229.19       3.985    .186    90.26  *
*    122    133.50 - 134.00    56.50 - 57.00       4.052    .866   197.31       3.974    .196    95.92  *
*    123    133.50 - 134.00    57.00 - 57.50       4.067    .855   168.53       3.974    .196   110.42  *
*    124    133.50 - 134.00    57.50 - 58.00       4.067    .855   140.16       3.920    .201   126.33  *
*    125    133.50 - 134.00    58.00 - 58.50       4.074    .850   120.07       3.919    .193   141.22  *
*    126    133.50 - 134.00    58.50 - 59.00       4.074    .850   125.09       3.925    .189   149.16  *
*    127    133.50 - 134.00    59.00 - 59.50       4.074    .850   131.27       3.927    .184   135.36  *
*    128    133.50 - 134.00    59.50 - 60.00       4.074    .850   145.02       3.591    .165   128.57  *
*    129    134.00 - 134.50    55.00 - 55.50       3.152    .049   182.22       3.949    .234    90.70  *
*    130    134.00 - 134.50    55.50 - 56.00       4.032    .883   250.79       3.973    .204    80.34  *
*    131    134.00 - 134.50    56.00 - 56.50       4.052    .866   215.70       4.000    .170    67.21  *
*    132    134.00 - 134.50    56.50 - 57.00       4.060    .860   183.17       3.990    .178    76.49  *
*    133    134.00 - 134.50    57.00 - 57.50       4.074    .850   153.26       3.990    .178    98.13  *
*    134    134.00 - 134.50    57.50 - 58.00       4.074    .850   120.46       3.937    .183   113.54  *
*    135    134.00 - 134.50    58.00 - 58.50       4.074    .850    83.59       3.937    .173   130.11  *
*    136    134.00 - 134.50    58.50 - 59.00       4.074    .850   104.71       3.943    .170   134.93  *
*    137    134.00 - 134.50    59.00 - 59.50       4.074    .850   108.05       3.945    .166   138.41  *
*    138    134.00 - 134.50    59.50 - 60.00       4.074    .850   125.37       3.629    .174   115.63  *
*    139    134.50 - 135.00    55.00 - 55.50       3.152    .049   174.95       3.956    .227    93.37  *
*    140    134.50 - 135.00    55.50 - 56.00       4.032    .883   240.84       3.978    .198    65.16  *
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                              SEISMIC MAP OF ALASKA
  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)     C(H)     R(H)        A(N)     B(N)     R(N)

   141   134.50 - 135.00   56.00 - 56.50      4.052    .866    204.73       4.005    .166     40.61
   142   134.50 - 135.00   56.50 - 57.00      4.060    .860    170.72       4.000    .170     36.57
   143   134.50 - 135.00   57.00 - 57.50      4.074    .850    139.51       4.000    .170     38.49
   144   134.50 - 135.00   57.50 - 58.00      4.074    .850    105.82       3.951    .171    104.20
   145   134.50 - 135.00   58.00 - 58.50      4.212    .883     53.61       3.943    .170    119.46
   146   134.50 - 135.00   58.50 - 59.00      4.212    .883    100.45       3.963    .161    120.90
   147   134.50 - 135.00   59.00 - 59.50      4.212    .883     88.03       3.965    .157    120.64
   148   134.50 - 135.00   59.50 - 60.00      4.212    .883    118.85       3.692    .148    105.90
   149   135.00 - 135.50   55.00 - 55.50      3.152    .049    168.49       3.956    .227     30.41
   150   135.00 - 135.50   55.50 - 56.00      4.032    .883    232.16       3.978    .198     35.99
   151   135.00 - 135.50   56.00 - 56.50      4.052    .866    195.06       4.005    .166     19.80
   152   135.00 - 135.50   56.50 - 57.00      4.067    .855    159.97       4.000    .170     36.69
   153   135.00 - 135.50   57.00 - 57.50      4.212    .883    142.75       4.000    .170     72.44
   154   135.00 - 135.50   57.50 - 58.00      4.212    .883    109.46       3.951    .171     97.98
   155   135.00 - 135.50   58.00 - 58.50      4.212    .883     79.85       4.204    .265    135.43
   156   135.00 - 135.50   58.50 - 59.00      4.212    .883     87.51       4.224    .250    128.10
   157   135.00 - 135.50   59.00 - 59.50      4.212    .883     52.10       4.225    .247    120.56
   158   135.00 - 135.50   59.50 - 60.00      4.212    .883    100.83       4.071    .187    120.49
   159   135.50 - 136.00   55.00 - 55.50      3.152    .049    162.83       3.956    .227     34.62
   160   135.50 - 136.00   55.50 - 56.00      4.032    .883    224.81       3.978    .198     56.03
   161   135.50 - 136.00   56.00 - 56.50      4.052    .866    186.82       4.005    .166     21.10
   162   135.50 - 136.00   56.50 - 57.00      4.067    .855    149.95       4.005    .166     47.84
   163   135.50 - 136.00   57.00 - 57.50      4.212    .883    128.53       4.124    .202     73.81
   164   135.50 - 136.00   57.50 - 58.00      4.212    .883     95.66       4.208    .268    116.58
   165   135.50 - 136.00   58.00 - 58.50      4.212    .883     71.82       4.233    .242    125.95
   166   135.50 - 136.00   58.50 - 59.00      4.212    .883     73.51       4.254    .226    108.48
   167   135.50 - 136.00   59.00 - 59.50      4.212    .883     72.33       4.263    .221     70.04
   168   135.50 - 136.00   59.50 - 60.00      4.212    .883     79.41       4.118    .161    104.96
   169   136.00 - 136.50   55.00 - 55.50      3.152    .049    157.94       3.946    .239     92.43
   170   136.00 - 136.50   55.50 - 56.00      4.032    .883    218.82       3.973    .204     43.90
   171   136.00 - 136.50   56.00 - 56.50      4.052    .866    180.20       4.000    .170     32.46
   172   136.00 - 136.50   56.50 - 57.00      4.067    .855    141.71       4.007    .162     43.65
   173   136.00 - 136.50   57.00 - 57.50      4.212    .883    114.06       4.147    .191     48.28
   174   136.00 - 136.50   57.50 - 58.00      4.212    .883     74.54       4.235    .247    114.89
   175   136.00 - 136.50   58.00 - 58.50      4.212    .883     46.52       4.236    .237    114.22
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***************************************************************************************************
*                            *     SEISMIC MAP OF ALASKA     *                                    *
***************************************************************************************************
*   GRID     LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)   C(N)    R(N)  *
***************************************************************************************************
*                                                                                                 *
*    176    136.00 - 136.50    58.50 - 59.00     4.212    .883    54.69       4.257   .222   33.34  *
*    177    136.00 - 136.50    59.00 - 59.50     4.212    .883    68.57       4.266   .217   53.19  *
*    178    136.00 - 136.50    59.50 - 60.00     4.212    .883    50.93       4.121   .157   39.11  *
*    179    136.00 - 136.50    60.00 - 60.50     4.207    .887    52.91       4.108   .160  111.05  *
*    180    136.00 - 136.50    60.50 - 61.00     4.207    .887   127.88       4.096   .165  128.76  *
*    181    136.50 - 137.00    55.00 - 55.50     3.152    .049   153.77       3.929   .249  101.84  *
*    182    136.50 - 137.00    55.50 - 56.00     4.032    .883   214.08       3.970   .208   77.94  *
*    183    136.50 - 137.00    56.00 - 56.50     4.052    .866   175.16       4.000   .170   58.23  *
*    184    136.50 - 137.00    56.50 - 57.00     4.067    .855   136.05       4.007   .162   66.12  *
*    185    136.50 - 137.00    57.00 - 57.50     4.212    .883   102.78       4.148   .188   81.52  *
*    186    136.50 - 137.00    57.50 - 58.00     4.212    .883    45.94       4.237   .245  118.00  *
*    187    136.50 - 137.00    58.00 - 58.50     4.322    .811    59.76       4.267   .221  107.29  *
*    188    136.50 - 137.00    58.50 - 59.00     4.322    .811    35.60       4.286   .208   55.77  *
*    189    136.50 - 137.00    59.00 - 59.50     4.322    .811    64.57       4.294   .204   38.23  *
*    190    136.50 - 137.00    59.50 - 60.00     4.322    .811    82.19       4.155   .149   81.99  *
*    191    136.50 - 137.00    60.00 - 60.50     4.317    .816    92.38       4.143   .151   90.34  *
*    192    136.50 - 137.00    60.50 - 61.00     4.317    .816   139.83       4.130   .156  119.06  *
*    193    137.00 - 137.50    55.00 - 55.50     3.152    .049   150.25       3.917   .263  113.14  *
*    194    137.00 - 137.50    55.50 - 56.00     4.032    .883   210.33       3.964   .214   93.53  *
*    195    137.00 - 137.50    56.00 - 56.50     4.052    .866   171.19       4.000   .170   81.00  *
*    196    137.00 - 137.50    56.50 - 57.00     4.067    .855   133.33       4.007   .162   85.81  *
*    197    137.00 - 137.50    57.00 - 57.50     4.322    .811   111.82       4.166   .177  108.11  *
*    198    137.00 - 137.50    57.50 - 58.00     4.322    .811    43.18       4.267   .229  126.30  *
*    199    137.00 - 137.50    58.00 - 58.50     4.322    .811    57.80       4.422   .238  116.96  *
*    200    137.00 - 137.50    58.50 - 59.00     4.322    .811    17.77       4.435   .227   52.56  *
*    201    137.00 - 137.50    59.00 - 59.50     4.322    .811    56.46       4.441   .224   56.31  *
*    202    137.00 - 137.50    59.50 - 60.00     4.322    .811    90.98       4.352   .186   93.66  *
*    203    137.00 - 137.50    60.00 - 60.50     4.317    .816   106.68       4.344   .189   70.75  *
*    204    137.00 - 137.50    60.50 - 61.00     4.317    .816   137.93       4.335   .194  127.00  *
*    205    137.50 - 138.00    55.00 - 55.50     3.152    .049   147.43       3.883   .287  122.82  *
*    206    137.50 - 138.00    55.50 - 56.00     4.032    .883   207.18       3.966   .240  106.34  *
*    207    137.50 - 138.00    56.00 - 56.50     4.052    .866   166.66       4.049   .195   88.01  *
*    208    137.50 - 138.00    56.50 - 57.00     4.067    .855   131.70       4.239   .227  121.68  *
*    209    137.50 - 138.00    57.00 - 57.50     4.322    .811   120.36       4.349   .219  139.61  *
*    210    137.50 - 138.00    57.50 - 58.00     4.322    .811    75.66       4.421   .244  144.38  *
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                         SEISMIC MAP OF ALASKA

 GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)    C(H)     R(H)        A(N)    C(N)    R(N)

 211    137.50 - 138.00    58.00 - 58.50    4.322   .811     65.01       4.473   .231   122.57
 212    137.50 - 138.00    58.50 - 59.00    4.322   .811     35.83       4.485   .222    81.41
 213    137.50 - 138.00    59.00 - 59.50    4.322   .811     43.40       4.490   .219    53.75
 214    137.50 - 138.00    59.50 - 60.00    4.322   .811     92.03       4.411   .184    97.40
 215    137.50 - 138.00    60.00 - 60.50    4.317   .816     91.15       4.404   .186   102.25
 216    137.50 - 138.00    60.50 - 61.00    4.317   .816    130.66       4.396   .190   123.00
 217    138.00 - 138.50    55.00 - 55.50    3.152   .049    145.57       3.864   .294   133.92
 218    138.00 - 138.50    55.50 - 56.00    4.032   .883    204.50       3.966   .240   115.42
 219    138.00 - 138.50    56.00 - 56.50    4.052   .866    153.68       4.094   .198    58.75
 220    138.00 - 138.50    56.50 - 57.00    4.067   .855    123.80       4.291   .229   134.74
 221    138.00 - 138.50    57.00 - 57.50    4.322   .811    132.13       4.399   .220   147.23
 222    138.00 - 138.50    57.50 - 58.00    4.322   .811    103.33       4.466   .240   148.18
 223    138.00 - 138.50    58.00 - 58.50    4.322   .811     80.84       4.539   .223   128.89
 224    138.00 - 138.50    58.50 - 59.00    4.322   .811     62.14       4.549   .215    76.36
 225    138.00 - 138.50    59.00 - 59.50    4.322   .811     71.31       4.553   .213    72.03
 226    138.00 - 138.50    59.50 - 60.00    4.322   .811     93.96       4.484   .183   102.13
 227    138.00 - 138.50    60.00 - 60.50    4.317   .816     57.99       4.479   .185   111.10
 228    138.00 - 138.50    60.50 - 61.00    4.317   .816    121.91       4.472   .188   117.56
 229    138.00 - 138.50    61.00 - 61.50    4.317   .816    162.28       4.543   .184   134.10
 230    138.00 - 138.50    61.50 - 62.00    4.304   .829    200.53       4.544   .183   150.96
 231    138.00 - 138.50    62.00 - 62.50    4.039   .663    211.05       4.539   .191   173.02
 232    138.00 - 138.50    62.50 - 63.00    4.023   .679    249.90       4.521   .212   197.66
 233    138.00 - 138.50    63.00 - 63.50    4.000   .704    290.66       4.312   .186   195.67
 234    138.00 - 138.50    63.50 - 64.00    3.041   .061    215.03       4.220   .163   201.83
 235    138.00 - 138.50    64.00 - 64.50    2.603   .000    205.64       3.846   .151   158.30
 236    138.00 - 138.50    64.50 - 65.00    2.603   .000    219.88       3.805   .147   144.92
 237    138.00 - 138.50    65.00 - 65.50    2.803   .000    228.13       3.768   .158   130.09
 238    138.00 - 138.50    65.50 - 66.00    2.603   .000    259.70       3.748   .158   116.34
 239    138.00 - 138.50    66.00 - 66.50    2.603   .000    283.83       3.749   .165   103.76
 240    138.00 - 138.50    66.50 - 67.00     .000   .000       .00       3.740   .171    92.51
 241    138.00 - 138.50    67.00 - 67.50     .000   .000       .00       3.774   .165    90.32
 242    138.00 - 138.50    67.50 - 68.00     .000   .000       .00       3.804   .164    90.08
 243    138.00 - 138.50    68.00 - 68.50     .000   .000       .00       3.797   .167   112.02
 244    138.00 - 138.50    68.50 - 69.00     .000   .000       .00       3.679   .201   128.08
 245    138.00 - 138.50    69.00 - 69.50     .000   .000       .00       3.598   .177   146.29
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*******************************************************************************************
*                        *     SEISMIC MAP OF ALASKA      *                               *
*******************************************************************************************
*  GRID    LONG1 - LONG2    LAT1 - LAT2       A(H)    B(H)     R(H)       A(N)   B(N)    R(N)  *
*******************************************************************************************
*                                                                                         *
*  246    138.00 - 138.50   69.50 - 70.00     .000    .000      .00      3.581   .183   159.48  *
*  247    138.00 - 138.50   70.00 - 70.50     .000    .000      .00      3.440   .181   154.70  *
*  248    138.00 - 138.50   70.50 - 71.00     .000    .000      .00      3.349   .165   156.01  *
*  249    138.50 - 139.00   55.00 - 55.50    3.152    .049   145.17      3.864   .294   147.93  *
*  250    138.50 - 139.00   55.50 - 56.00    4.032    .883   203.19      3.968   .240   130.21  *
*  251    138.50 - 139.00   56.00 - 56.50    4.052    .866   146.16      4.108   .193   106.12  *
*  252    138.50 - 139.00   56.50 - 57.00    4.067    .855    91.95      4.327   .232   145.11  *
*  253    138.50 - 139.00   57.00 - 57.50    4.322    .811   138.81      4.431   .220   135.22  *
*  254    138.50 - 139.00   57.50 - 58.00    4.322    .811   122.00      4.529   .232   150.53  *
*  255    138.50 - 139.00   58.00 - 58.50    4.354    .777   103.11      4.600   .210   126.46  *
*  256    138.50 - 139.00   58.50 - 59.00    4.354    .777    89.01      4.609   .204    95.47  *
*  257    138.50 - 139.00   59.00 - 59.50    4.354    .777    93.40      4.612   .202    69.39  *
*  258    138.50 - 139.00   59.50 - 60.00    4.354    .777    98.08      4.549   .180   102.59  *
*  259    138.50 - 139.00   60.00 - 60.50    4.354    .777    85.63      4.545   .181   105.68  *
*  260    138.50 - 139.00   60.50 - 61.00    4.354    .777   117.77      4.543   .184   107.74  *
*  261    138.50 - 139.00   61.00 - 61.50    4.322    .811   154.59      4.678   .204   127.99  *
*  262    138.50 - 139.00   61.50 - 62.00    4.311    .822   194.63      4.678   .205   147.15  *
*  263    138.50 - 139.00   62.00 - 62.50    4.046    .657   202.78      4.674   .211   172.60  *
*  264    138.50 - 139.00   62.50 - 63.00    4.031    .670   239.16      4.649   .213   200.05  *
*  265    138.50 - 139.00   63.00 - 63.50    4.013    .690   276.69      4.353   .166   192.96  *
*  266    138.50 - 139.00   63.50 - 64.00    3.041    .061   200.64      4.312   .174   210.55  *
*  267    138.50 - 139.00   64.00 - 64.50    2.803    .000   191.28      3.875   .151   165.17  *
*  268    138.50 - 139.00   64.50 - 65.00    2.603    .000   206.32      3.814   .140   153.71  *
*  269    138.50 - 139.00   65.00 - 65.50    2.603    .000   225.68      3.779   .148   140.98  *
*  270    138.50 - 139.00   65.50 - 66.00    2.803    .000   248.33      3.759   .147   128.10  *
*  271    138.50 - 139.00   66.00 - 66.50    2.803    .000   273.47      3.757   .160   116.52  *
*  272    138.50 - 139.00   66.50 - 67.00     .000    .000      .00      3.764   .170   108.61  *
*  273    138.50 - 139.00   67.00 - 67.50     .000    .000      .00      3.797   .167   107.12  *
*  274    138.50 - 139.00   67.50 - 68.00     .000    .000      .00      3.804   .164   109.05  *
*  275    138.50 - 139.00   68.00 - 68.50     .000    .000      .00      3.797   .167   125.46  *
*  276    138.50 - 139.00   68.50 - 69.00     .000    .000      .00      3.679   .201   135.05  *
*  277    138.50 - 139.00   69.00 - 69.50     .000    .000      .00      3.615   .172   148.30  *
*  278    138.50 - 139.00   69.50 - 70.00     .000    .000      .00      3.598   .177   156.13  *
*  279    138.50 - 139.00   70.00 - 70.50     .000    .000      .00      3.463   .175   148.39  *
*  280    138.50 - 139.00   70.50 - 71.00     .000    .000      .00      3.373   .160   148.68  *
*                                                                                         *
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*                      *   SEISMIC MAP OF ALASKA   *                                         *
**********************************************************************************************
*  GRID   LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)    R(H)       A(N)   C(N)    R(V)  *
**********************************************************************************************
*                                                                                            *
*  281   139.00 - 139.50   55.00 - 55.50      3.152   .049   146.92      3.804   .295   157.60 *
*  282   139.00 - 139.50   55.50 - 56.00      4.032   .883   205.48      3.920   .235   144.80 *
*  283   139.00 - 139.50   56.00 - 56.50      4.052   .866   139.66      4.081   .179   138.56 *
*  284   139.00 - 139.50   56.50 - 57.00      4.067   .855    48.56      4.393   .218   155.39 *
*  285   139.00 - 139.50   57.00 - 57.50      4.322   .811   143.62      4.485   .209    93.71 *
*  286   139.00 - 139.50   57.50 - 58.00      4.354   .777   142.46      4.592   .217   151.24 *
*  287   139.00 - 139.50   58.00 - 58.50      4.354   .777   122.66      4.729   .210   110.13 *
*  288   139.00 - 139.50   58.50 - 59.00      4.354   .777   109.91      4.734   .206    77.06 *
*  289   139.00 - 139.50   59.00 - 59.50      4.354   .777   105.28      4.737   .205   106.34 *
*  290   139.00 - 139.50   59.50 - 60.00      4.354   .777    91.72      4.685   .203   101.19 *
*  291   139.00 - 139.50   60.00 - 60.50      4.358   .773    77.99      4.682   .204   100.31 *
*  292   139.00 - 139.50   60.50 - 61.00      4.358   .773   105.39      4.680   .205    98.24 *
*  293   139.00 - 139.50   61.00 - 61.50      4.322   .811   146.61      4.778   .197   112.49 *
*  294   139.00 - 139.50   61.50 - 62.00      4.311   .822   189.28      4.778   .198   137.53 *
*  295   139.00 - 139.50   62.00 - 62.50      4.046   .657   196.71      4.775   .202   167.73 *
*  296   139.00 - 139.50   62.50 - 63.00      4.031   .670   232.27      4.731   .196   196.36 *
*  297   139.00 - 139.50   63.00 - 63.50      4.013   .690   268.18      4.449   .161   195.27 *
*  298   139.00 - 139.50   63.50 - 64.00      3.041   .061   186.15      4.357   .162   210.76 *
*  299   139.00 - 139.50   64.00 - 64.50      2.803   .000   176.88      3.910   .166   170.41 *
*  300   139.00 - 139.50   64.50 - 65.00      2.803   .000   193.06      3.847   .156   163.30 *
*  301   139.00 - 139.50   65.00 - 65.50      2.803   .000   213.63      3.802   .151   151.97 *
*  302   139.00 - 139.50   65.50 - 66.00      2.803   .000   237.44      3.767   .142   138.81 *
*  303   139.00 - 139.50   66.00 - 66.50      2.803   .000   263.61      3.783   .142   130.64 *
*  304   139.00 - 139.50   66.50 - 67.00       .000   .000      .00      3.785   .155   123.76 *
*  305   139.00 - 139.50   67.00 - 67.50       .000   .000      .00      3.804   .164   122.15 *
*  306   139.00 - 139.50   67.50 - 68.00      3.062   .671   302.79      3.850   .182   129.11 *
*  307   139.00 - 139.50   68.00 - 68.50       .000   .000      .00      3.804   .164   137.79 *
*  308   139.00 - 139.50   68.50 - 69.00       .000   .000      .00      3.687   .200   141.10 *
*  309   139.00 - 139.50   69.00 - 69.50       .000   .000      .00      3.631   .168   148.80 *
*  310   139.00 - 139.50   69.50 - 70.00       .000   .000      .00      3.615   .172   151.29 *
*  311   139.00 - 139.50   70.00 - 70.50       .000   .000      .00      3.485   .170   140.70 *
*  312   139.00 - 139.50   70.50 - 71.00       .000   .000      .00      3.451   .165   146.62 *
*  313   139.50 - 140.00   55.00 - 55.50      3.152   .049   151.30      3.825   .287   175.76 *
*  314   139.50 - 140.00   55.50 - 56.00      4.032   .883   213.22      3.943   .224   165.08 *
*  315   139.50 - 140.00   56.00 - 56.50      4.052   .866   153.15      4.160   .177   165.28 *
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*                   *          SEISMIC MAP OF ALASKA           *                        *
*****************************************************************************************
*  GRID   LONG1 - LONG2      LAT1 - LAT2       A(H)   C(H)    R(H)       A(N)   C(N)    R(N)   *
*****************************************************************************************
*                                                                                       *
*   316  139.50 - 140.00    56.50 - 57.00     4.067   .855    95.33     4.554   .239  175.04   *
*   317  139.50 - 140.00    57.00 - 57.50     4.322   .811   158.40     4.631   .223   94.49   *
*   318  139.50 - 140.00    57.50 - 58.00     4.354   .777   158.48     4.723   .214  160.92   *
*   319  139.50 - 140.00    58.00 - 58.50     4.354   .777   140.68     4.819   .199  145.07   *
*   320  139.50 - 140.00    58.50 - 59.00     4.354   .777   126.47     4.823   .196  120.38   *
*   321  139.50 - 140.00    59.00 - 59.50     4.354   .777   110.35     4.825   .196  119.90   *
*   322  139.50 - 140.00    59.50 - 60.00     4.354   .777    75.34     4.782   .197   84.23   *
*   323  139.50 - 140.00    60.00 - 60.50     4.358   .773    48.11     4.781   .197   67.55   *
*   324  139.50 - 140.00    60.50 - 61.00     4.358   .773    90.35     4.780   .198   79.88   *
*   325  139.50 - 140.00    61.00 - 61.50     4.322   .811   140.20     4.868   .202   87.26   *
*   326  139.50 - 140.00    61.50 - 62.00     4.311   .822   185.35     4.865   .202  119.36   *
*   327  139.50 - 140.00    62.00 - 62.50     4.046   .657   191.63     4.862   .205  160.71   *
*   328  139.50 - 140.00    62.50 - 63.00     4.031   .670   226.09     4.821   .197  193.90   *
*   329  139.50 - 140.00    63.00 - 63.50     4.013   .690   259.80     4.554   .159  198.27   *
*   330  139.50 - 140.00    63.50 - 64.00     3.223   .135   186.26     4.384   .138  206.24   *
*   331  139.50 - 140.00    64.00 - 64.50     3.006   .258   175.56     3.943   .165  171.27   *
*   332  139.50 - 140.00    64.50 - 65.00     3.006   .258   193.23     3.875   .145  168.68   *
*   333  139.50 - 140.00    65.00 - 65.50     3.006   .258   214.77     3.824   .140  160.43   *
*   334  139.50 - 140.00    65.50 - 66.00     2.803   .000   227.09     3.791   .127  149.85   *
*   335  139.50 - 140.00    66.00 - 66.50     3.245   .470   236.48     3.868   .165  147.40   *
*   336  139.50 - 140.00    66.50 - 67.00     3.062   .671   248.18     3.869   .175  142.94   *
*   337  139.50 - 140.00    67.00 - 67.50     3.062   .671   268.90     3.867   .178  140.64   *
*   338  139.50 - 140.00    67.50 - 68.00     3.062   .671   292.23     4.073   .160  170.03   *
*   339  139.50 - 140.00    68.00 - 68.50      .000   .000      .00     3.823   .156  149.03   *
*   340  139.50 - 140.00    68.50 - 69.00      .000   .000      .00     3.695   .199  145.40   *
*   341  139.50 - 140.00    69.00 - 69.50      .000   .000      .00     3.675   .172  150.33   *
*   342  139.50 - 140.00    69.50 - 70.00      .000   .000      .00     3.660   .177  147.66   *
*   343  139.50 - 140.00    70.00 - 70.50      .000   .000      .00     3.546   .173  135.92   *
*   344  139.50 - 140.00    70.50 - 71.00      .000   .000      .00     3.451   .165  135.09   *
*   345  140.00 - 140.50    55.00 - 55.50     3.103   .001   154.75     3.811   .310  191.80   *
*   346  140.00 - 140.50    55.50 - 56.00     4.019   .895   225.09     3.934   .240  181.18   *
*   347  140.00 - 140.50    56.00 - 56.50     4.043   .873   177.85     4.244   .193  186.42   *
*   348  140.00 - 140.50    56.50 - 57.00     4.060   .860   144.59     4.624   .238  189.23   *
*   349  140.00 - 140.50    57.00 - 57.50     4.317   .816   179.63     4.705   .218  154.38   *
*   350  140.00 - 140.50    57.50 - 58.00     4.349   .782   174.30     4.811   .205  169.86   *
*                                                                                       *
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                                        SEISMIC MAP OF ALASKA

   GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)         A(N)    C(N)     P(N)

   351     140.00 - 140.50     58.00 - 58.50      4.354   .777    156.86        4.897   .200    157.42
   352     140.00 - 140.50     58.50 - 59.00      4.354   .777    139.63        4.902   .198    137.79
   353     140.00 - 140.50     59.00 - 59.50      4.354   .777    113.41        4.905   .198    122.01
   354     140.00 - 140.50     59.50 - 60.00      4.354   .777     53.63        4.869   .202     92.06
   355     140.00 - 140.50     60.00 - 60.50      4.358   .773     24.99        4.867   .202     65.64
   356     140.00 - 140.50     60.50 - 61.00      4.358   .773     83.07        4.866   .203     65.00
   357     140.00 - 140.50     61.00 - 61.50      4.369   .769    142.94        4.992   .199     92.49
   358     140.00 - 140.50     61.50 - 62.00      4.359   .779    189.72        4.991   .199     93.54
   359     140.00 - 140.50     62.00 - 62.50      4.105   .606    154.40        4.986   .202    158.62
   360     140.00 - 140.50     62.50 - 63.00      4.093   .618    226.08        4.941   .202    195.74
   361     140.00 - 140.50     63.00 - 63.50      4.076   .634    256.12        4.686   .175    205.76
   362     140.00 - 140.50     63.50 - 64.00      3.551   .290    197.32        4.454   .125    202.39
   363     140.00 - 140.50     64.00 - 64.50      3.446   .382    193.42        4.035   .227    169.70
   364     140.00 - 140.50     64.50 - 65.00      3.446   .382    204.10        3.957   .188    170.51
   365     140.00 - 140.50     65.00 - 65.50      3.414   .414    215.47        3.897   .174    166.16
   366     140.00 - 140.50     65.50 - 66.00      3.245   .470    205.56        3.872   .159    160.79
   367     140.00 - 140.50     66.00 - 66.50      3.245   .470    224.71        4.104   .134    177.45
   368     140.00 - 140.50     66.50 - 67.00      3.062   .671    236.11        4.105   .140    177.54
   369     140.00 - 140.50     67.00 - 67.50      3.062   .671    257.79        4.095   .150    177.74
   370     140.00 - 140.50     67.50 - 68.00      3.062   .671    282.05        4.144   .146    187.06
   371     140.00 - 140.50     68.00 - 68.50       .000   .000       .00        3.845   .159    157.21
   372     140.00 - 140.50     68.50 - 69.00       .000   .000       .00        3.716   .205    148.02
   373     140.00 - 140.50     69.00 - 69.50       .000   .000       .00        3.675   .172    146.37
   374     140.00 - 140.50     69.50 - 70.00       .000   .000       .00        3.660   .177    138.27
   375     140.00 - 140.50     70.00 - 70.50       .000   .000       .00        3.546   .173    123.68
   376     140.00 - 140.50     70.50 - 71.00       .000   .000       .00        3.451   .165    123.19
   377     140.50 - 141.00     55.00 - 55.50      3.103   .001    164.16        3.517   .211    183.13
   378     140.50 - 141.00     55.50 - 56.00      4.019   .895    240.88        3.731   .178    179.03
   379     140.50 - 141.00     56.00 - 56.50      4.032   .883    202.31        4.247   .195    203.26
   380     140.50 - 141.00     56.50 - 57.00      4.052   .866    177.35        4.629   .258    194.53
   381     140.50 - 141.00     57.00 - 57.50      4.311   .822    199.99        4.748   .244    177.13
   382     140.50 - 141.00     57.50 - 58.00      4.343   .788    189.73        4.859   .212    170.92
   383     140.50 - 141.00     58.00 - 58.50      4.354   .777    171.64        5.012   .206    164.31
   384     140.50 - 141.00     58.50 - 59.00      4.354   .777    151.10        5.017   .203    143.35
   385     140.50 - 141.00     59.00 - 59.50      4.391   .744    125.06        5.019   .203    123.31
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
386	140.50 - 141.00	59.50 - 60.00	4.391	.744	78.89	4.993	.201	85.25
387	140.50 - 141.00	60.00 - 60.50	4.395	.740	49.71	4.992	.200	43.17
388	140.50 - 141.00	60.50 - 61.00	4.395	.740	52.35	4.991	.200	43.26
389	140.50 - 141.00	61.00 - 61.50	4.373	.764	144.06	5.092	.185	106.75
390	140.50 - 141.00	61.50 - 62.00	4.421	.744	198.44	5.094	.186	97.96
391	140.50 - 141.00	62.00 - 62.50	4.183	.574	200.34	5.088	.187	147.65
392	140.50 - 141.00	62.50 - 63.00	4.172	.586	226.28	5.049	.186	195.37
393	140.50 - 141.00	63.00 - 63.50	4.159	.601	247.85	4.822	.160	209.38
394	140.50 - 141.00	63.50 - 64.00	3.571	.267	182.19	4.599	.138	204.01
395	140.50 - 141.00	64.00 - 64.50	3.470	.361	180.08	4.337	.142	193.21
396	140.50 - 141.00	64.50 - 65.00	3.446	.382	189.98	4.146	.183	179.08
397	140.50 - 141.00	65.00 - 65.50	3.414	.414	201.76	4.059	.155	174.86
398	140.50 - 141.00	65.50 - 66.00	3.245	.470	194.29	3.995	.130	170.62
399	140.50 - 141.00	66.00 - 66.50	3.245	.470	213.19	4.193	.127	185.18
400	140.50 - 141.00	66.50 - 67.00	3.062	.671	224.35	4.185	.132	187.96
401	140.50 - 141.00	67.00 - 67.50	3.062	.671	247.07	4.172	.142	190.74
402	140.50 - 141.00	67.50 - 68.00	3.331	.428	246.42	4.145	.144	193.65
403	140.50 - 141.00	68.00 - 68.50	3.201	.000	299.81	3.845	.159	162.44
404	140.50 - 141.00	68.50 - 69.00	.000	.000	.00	3.714	.205	148.54
405	140.50 - 141.00	69.00 - 69.50	.000	.000	.00	3.744	.188	149.05
406	140.50 - 141.00	69.50 - 70.00	.000	.000	.00	3.731	.192	135.69
407	140.50 - 141.00	70.00 - 70.50	.000	.000	.00	3.546	.173	110.36
408	140.50 - 141.00	70.50 - 71.00	.000	.000	.00	3.451	.165	111.02
409	141.00 - 141.50	55.00 - 55.50	3.103	.001	175.49	3.337	.206	188.71
410	141.00 - 141.50	55.50 - 56.00	4.019	.895	257.96	3.567	.171	173.94
411	141.00 - 141.50	56.00 - 56.50	4.032	.883	225.30	4.213	.178	206.37
412	141.00 - 141.50	56.50 - 57.00	4.052	.866	202.52	4.709	.224	206.12
413	141.00 - 141.50	57.00 - 57.50	4.317	.816	219.11	4.898	.221	195.16
414	141.00 - 141.50	57.50 - 58.00	4.349	.782	205.40	4.977	.210	177.45
415	141.00 - 141.50	58.00 - 58.50	4.349	.782	185.00	5.088	.194	162.24
416	141.00 - 141.50	58.50 - 59.00	4.354	.777	162.31	5.094	.190	139.17
417	141.00 - 141.50	59.00 - 59.50	4.391	.744	135.80	5.096	.190	118.17
418	141.00 - 141.50	59.50 - 60.00	4.391	.744	97.54	9.091	.187	90.63
419	141.00 - 141.50	60.00 - 60.50	4.395	.740	76.43	5.091	.187	61.57
420	141.00 - 141.50	60.50 - 61.00	4.395	.740	103.76	5.091	.187	68.69

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*                          *     SEISMIC MAP OF ALASKA      *                          *
   GRID    LONG1 - LONG2      LAT1 - LAT2        Δ(H)    Q(H)     R(H)        Δ(N)    Q(N)     R(N)

    421   141.00 - 141.50    61.00 - 61.50      4.373   .764   147.37       5.173   .185   107.63
    422   141.00 - 141.50    61.50 - 62.00      4.426   .739   198.86       5.187   .186   115.84
    423   141.00 - 141.50    62.00 - 62.50      4.188   .570   196.02       5.183   .186   119.92
    424   141.00 - 141.50    62.50 - 63.00      4.178   .580   217.26       5.149   .186   195.33
    425   141.00 - 141.50    63.00 - 63.50      4.166   .593   234.07       4.952   .165   209.73
    426   141.00 - 141.50    63.50 - 64.00      3.648   .204   173.02       4.704   .138   202.65
    427   141.00 - 141.50    64.00 - 64.50      3.588   .249   179.59       4.513   .124   199.82
    428   141.00 - 141.50    64.50 - 65.00      3.470   .361   177.74       4.328   .117   187.55
    429   141.00 - 141.50    65.00 - 65.50      3.414   .414   188.24       4.120   .171   165.35
    430   141.00 - 141.5[illegible]   65.50 - 66.00      3.245   .470   182.22       4.071   .158   165.71
    431   141.00 - 141[illegible]     66.00 - 66.50      3.379   .425   173.86       4.133   .172   176.06
    432   141.00 - 141[illegible]     66.50 - 67.00      3.350   .425   195.61       4.116   .168   180.63
    433   141.00 - 141.50    67.00 - 67.50      3.350   .425   213.66       4.074   .159   181.41
    434   141.00 - 141.50    67.50 - 68.00      3.566   .457   267.51       4.160   .149   197.01
    435   141.00 - 141.50    68.00 - 68.50      3.201   .000   289.55       3.869   .175   166.28
    436   141.00 - 141.50    68.50 - 69.00       .000   .000      .00       3.747   .224   149.59
    437   141.00 - 141.50    69.00 - 69.50       .000   .000      .00       3.744   .188   142.24
    438   141.00 - 141.50    69.50 - 70.00       .000   .000      .00       3.731   .192   123.19
    439   141.00 - 141.50    70.00 - 70.50       .000   .000      .00       3.546   .173    96.02
    440   141.00 - 141.50    70.50 - 71.00       .000   .000      .00       3.451   .165    98.72
    441   141.00 - 141.50    71.00 - 71.50       .000   .000      .00       3.373   .217   115.35
    442   141.00 - 141.50    71.50 - 72.00       .000   .000      .00       3.304   .248   136.85
    443   141.50 - 142.00    55.00 - 55.50      3.041   .061   184.78       3.257   .175   192.02
    444   141.50 - 142.00    55.50 - 56.00      4.003   .912   275.09       3.534   .151   179.07
    445   141.50 - 142.00    56.00 - 56.50      4.019   .895   246.35       4.230   .185   210.53
    446   141.50 - 142.00    56.50 - 57.00      4.032   .883   224.01       4.766   .217   208.94
    447   141.50 - 142.00    57.00 - 57.50      4.297   .836   235.81       5.002   .205   201.02
    448   141.50 - 142.00    57.50 - 58.00      4.331   .801   219.88       5.069   .201   178.75
    449   141.50 - 142.00    58.00 - 58.50      4.354   .777   198.41       5.157   .189   158.58
    450   141.50 - 142.00    58.50 - 59.00      4.358   .773   173.62       5.166   .188   132.21
    451   141.50 - 142.00    59.00 - 59.50      4.395   .740   146.85       5.171   .188   110.15
    452   141.50 - 142.00    59.50 - 60.00      4.395   .740   105.98       5.171   .187    91.74
    453   141.50 - 142.00    60.00 - 60.50      4.399   .736    67.84       5.171   .187    80.01
    454   141.50 - 142.00    60.50 - 61.00      4.399   .736   108.59       5.172   .186    90.10
    455   141.50 - 142.00    61.00 - 61.50      4.399   .736   154.25       5.234   .184   113.17
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                              SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)     R(N)

   456   141.50 - 142.00    61.50 - 62.00      4.449    .713   201.74      5.249    .185   142.35
   457   141.50 - 142.00    62.00 - 62.50      4.213    .542   193.05      5.246    .185   158.66
   458   141.50 - 142.00    62.50 - 63.00      4.209    .546   208.73      5.207    .184   194.28
   459   141.50 - 142.00    63.00 - 63.50      4.199    .557   220.14      5.027    .166   205.70
   460   141.50 - 142.00    63.50 - 64.00      3.756    .120   156.77      4.727    .128   191.85
   461   141.50 - 142.00    64.00 - 64.50      3.717    .148   162.76      4.540    .118   107.20
   462   141.50 - 142.00    64.50 - 65.00      3.557    .324   152.01      4.366    .114   176.67
   463   141.50 - 142.00    65.00 - 65.50      3.535    .327   160.39      4.169    .188   158.05
   464   141.50 - 142.00    65.50 - 66.00      3.379    .425   150.46      4.128    .173   161.76
   465   141.50 - 142.00    66.00 - 66.50      3.610    .434   189.78      4.143    .182   168.51
   466   141.50 - 142.00    66.50 - 67.00      3.583    .447   211.69      4.117    .169   174.21
   467   141.50 - 142.00    67.00 - 67.50      3.583    .447   232.47      4.069    .165   176.16
   468   141.50 - 142.00    67.50 - 68.00      3.583    .447   254.02      4.053    .163   183.25
   469   141.50 - 142.00    68.00 - 68.50      3.280    .000   282.66      3.726    .234   149.98
   470   141.50 - 142.00    68.50 - 69.00       .000    .000      .00      3.757    .183   152.24
   471   141.50 - 142.00    69.00 - 69.50       .000    .000      .00      3.744    .188   134.73
   472   141.50 - 142.00    69.50 - 70.00       .000    .000      .00      3.731    .192   109.87
   473   141.50 - 142.00    70.00 - 70.50       .000    .000      .00      3.546    .173    80.70
   474   141.50 - 142.00    70.50 - 71.00       .000    .000      .00      3.451    .165    86.53
   475   141.50 - 142.00    71.00 - 71.50       .000    .000      .00      3.373    .217   106.44
   476   141.50 - 142.00    71.50 - 72.00       .000    .000      .00      3.304    .248   130.02
   477   142.00 - 142.50    55.00 - 55.50      2.953    .149   195.23      3.257    .175   192.88
   478   142.00 - 142.50    55.50 - 56.00      3.980    .938   292.10      3.521    .151   179.79
   479   142.00 - 142.50    56.00 - 56.50      4.003    .912   267.10      4.238    .199   210.22
   480   142.00 - 142.50    56.50 - 57.00      4.019    .895   245.34      4.810    .217   208.64
   481   142.00 - 142.50    57.00 - 57.50      4.288    .846   252.39      5.065    .201   200.82
   482   142.00 - 142.50    57.50 - 58.00      4.323    .809   234.27      5.128    .198   176.35
   483   142.00 - 142.50    58.00 - 58.50      4.362    .771   214.67      5.202    .190   151.60
   484   142.00 - 142.50    58.50 - 59.00      4.372    .760   188.23      5.222    .190   118.11
   485   142.00 - 142.50    59.00 - 59.50      4.407    .729   159.62      5.226    .190    95.27
   486   142.00 - 142.50    59.50 - 60.00      4.407    .729   110.85      5.227    .189    71.59
   487   142.00 - 142.50    60.00 - 60.50      4.411    .724    39.05      5.229    .188    71.96
   488   142.00 - 142.50    60.50 - 61.00      4.411    .724   110.62      5.231    .186    79.48
   489   142.00 - 142.50    61.00 - 61.50      4.443    .694   161.81      5.260    .177   119.00
   490   142.00 - 142.50    61.50 - 62.00      4.490    .671   205.17      5.278    .178   146.67
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
491	142.00 - 142.50	62.00 - 62.50	4.271	.487	189.36	5.271	.178	168.84
492	142.00 - 142.50	62.50 - 63.00	4.268	.489	196.60	5.231	.178	189.14
493	142.00 - 142.50	63.00 - 63.50	4.262	.495	199.89	5.052	.160	197.04
494	142.00 - 142.50	63.50 - 64.00	3.897	.215	156.15	4.748	.118	180.53
495	142.00 - 142.50	64.00 - 64.50	3.862	.243	163.88	4.566	.106	174.58
496	142.00 - 142.50	64.50 - 65.00	3.725	.376	155.90	4.39[illegible]	.108	165.39
497	142.00 - 142.50	65.00 - 65.50	3.704	.387	163.65	4.201	.202	148.39
498	142.00 - 142.50	65.50 - 66.00	3.610	.434	163.04	4.159	.188	153.32
499	142.00 - 142.50	66.00 - 66.50	3.632	.428	175.80	4.151	.184	161.22
500	142.00 - 142.50	66.50 - 67.00	3.610	.434	197.12	4.123	.170	168.42
501	142.00 - 142.50	67.00 - 67.50	3.610	.434	218.03	4.073	.165	172.48
502	142.00 - 142.50	67.50 - 68.00	3.583	.447	244.63	4.046	.150	177.19
503	142.00 - 142.50	68.00 - 68.50	3.280	.000	273.06	3.862	.144	167.93
504	142.00 - 142.50	68.50 - 69.00	.000	.000	.00	3.811	.157	154.23
505	142.00 - 142.50	69.00 - 69.50	.000	.000	.00	3.744	.188	127.01
506	142.00 - 142.50	69.50 - 70.00	.000	.000	.00	3.731	.192	96.38
507	142.00 - 142.50	70.00 - 70.50	.000	.000	.00	3.546	.173	64.48
508	142.00 - 142.50	70.50 - 71.00	.000	.000	.00	3.451	.165	74.84
509	142.00 - 142.50	71.00 - 71.50	.000	.000	.00	3.373	.217	98.38
510	142.00 - 142.50	71.50 - 72.00	.000	.000	.00	3.321	.226	124.99
511	142.50 - 143.00	55.00 - 55.50	2.502	.000	168.36	3.257	.175	191.97
512	142.50 - 143.00	55.50 - 56.00	2.502	.000	149.65	3.484	.164	176.90
513	142.50 - 143.00	56.00 - 56.50	2.803	.000	171.32	4.315	.233	215.14
514	142.50 - 143.00	56.50 - 57.00	2.979	.000	177.92	4.851	.220	206.86
515	142.50 - 143.00	57.00 - 57.50	3.952	.764	259.49	5.106	.204	197.49
516	142.50 - 143.00	57.50 - 58.00	4.023	.679	237.61	5.165	.198	171.65
517	142.50 - 143.00	58.00 - 58.50	4.398	.739	231.97	5.224	.185	143.46
518	142.50 - 143.00	58.50 - 59.00	4.407	.730	203.80	5.243	.184	69.47
519	142.50 - 143.00	59.00 - 59.50	4.439	.700	174.52	5.247	.184	71.58
520	142.50 - 143.00	59.50 - 60.00	4.439	.700	126.52	5.249	.183	42.86
521	142.50 - 143.00	60.00 - 60.50	4.443	.695	75.44	5.251	.183	71.86
522	142.50 - 143.00	60.50 - 61.00	4.443	.695	121.05	5.255	.181	81.81
523	142.50 - 143.00	61.00 - 61.50	4.436	.700	161.43	5.296	.175	112.07
524	142.50 - 143.00	61.50 - 62.00	4.525	.658	208.70	5.310	.175	144.61
525	142.50 - 143.00	62.00 - 62.50	4.313	.477	187.82	5.304	.176	168.22

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*                              *    SEISMIC MAP OF ALASKA        *
  GRID      LONG1 - LONG2       LAT1 - LAT2        A(H)    B(H)    R(H)        A(N)    B(N)    R(N)

   526     142.50 - 143.00     62.50 - 63.00      4.310   .480   186.16       5.266   .177   179.15
   527     142.50 - 143.00     63.00 - 63.50      4.307   .483   179.55       5.074   .156   187.54
   528     142.50 - 143.00     63.50 - 64.00      4.046   .229   154.16       4.771   .115   168.66
   529     142.50 - 143.00     64.00 - 64.50      3.919   .202   153.42       4.587   .106   162.05
   530     142.50 - 143.00     64.50 - 65.00      3.750   .368   142.24       4.415   .107   153.51
   531     142.50 - 143.00     65.00 - 65.50      3.725   .376   149.26       4.219   .212   138.90
   532     142.50 - 143.00     65.50 - 66.00      3.632   .428   149.34       4.174   .197   145.20
   533     142.50 - 143.00     66.00 - 66.50      3.632   .428   164.94       4.296   .110   169.17
   534     142.50 - 143.00     66.50 - 67.00      3.610   .434   186.46       4.158   .176   162.51
   535     142.50 - 143.00     67.00 - 67.50      3.610   .434   208.42       4.083   .162   166.01
   536     142.50 - 143.00     67.50 - 68.00      3.678   .356   249.59       4.200   .111   189.07
   537     142.50 - 143.00     68.00 - 68.50      3.280   .000   263.90       3.935   .282   163.71
   538     142.50 - 143.00     68.50 - 69.00       .000   .000      .00       3.881   .130   156.97
   539     142.50 - 143.00     69.00 - 69.50       .000   .000      .00       3.744   .188   119.59
   540     142.50 - 143.00     69.50 - 70.00       .000   .000      .00       3.731   .192    83.74
   541     142.50 - 143.00     70.00 - 70.50       .000   .000      .00       3.546   .173    47.51
   542     142.50 - 143.00     70.50 - 71.00       .000   .000      .00       3.461   .151    64.86
   543     142.50 - 143.00     71.00 - 71.50       .000   .000      .00       3.387   .198    92.27
   544     142.50 - 143.00     71.50 - 72.00       .000   .000      .00       3.321   .226   119.81
   545     143.00 - 143.50     55.00 - 55.50      2.502   .000   183.61       3.295   .162   190.37
   546     143.00 - 143.50     55.50 - 56.00      2.502   .000   166.62       3.521   .151   175.38
   547     143.00 - 143.50     56.00 - 56.50      2.502   .000   155.53       4.352   .217   212.29
   548     143.00 - 143.50     56.50 - 57.00      2.803   .000   178.63       4.874   .216   202.26
   549     143.00 - 143.50     57.00 - 57.50      4.013   .690   284.09       5.132   .199   192.56
   550     143.00 - 143.50     57.50 - 58.00      4.053   .651   251.17       5.189   .192   166.06
   551     143.00 - 143.50     58.00 - 58.50      4.128   .584   218.34       5.260   .186   139.77
   552     143.00 - 143.50     58.50 - 59.00      4.138   .576   183.59       5.279   .185    94.07
   553     143.00 - 143.50     59.00 - 59.50      4.180   .536   154.07       5.283   .184    67.38
   554     143.00 - 143.50     59.50 - 60.00      4.180   .536   116.36       5.285   .183    57.21
   555     143.00 - 143.50     60.00 - 60.50      4.184   .532    89.77       5.288   .182    73.01
   556     143.00 - 143.50     60.50 - 61.00      4.184   .532    95.92       5.291   .180    75.22
   557     143.00 - 143.50     61.00 - 61.50      4.520   .642   165.74       5.155   .406    76.84
   558     143.00 - 143.50     61.50 - 62.00      4.587   .611   208.32       5.164   .410   117.12
   559     143.00 - 143.50     62.00 - 62.50      4.377   .444   181.95       5.158   .407   137.55
   560     143.00 - 143.50     62.50 - 63.00      4.375   .446   172.18       5.128   .395   129.87
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*                    *  .  -  SEISMIC MAP OF ALASKA      *                                 *
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*  GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)    C(H)     R(H)       A(N)    C(N)     R(N)   *
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*
*   561   143.00 - 143.50    63.00 - 63.50     4.371   .450   151.20      5.090   .150   177.12  *
*   562   143.00 - 143.50    63.50 - 64.00     4.046   .229   135.26      4.751   .220   143.72  *
*   563   143.00 - 143.50    64.00 - 64.50     3.919   .202   140.35      4.619   .166   146.61  *
*   564   143.00 - 143.50    64.50 - 65.00     3.750   .368   129.65      4.483   .120   144.23  *
*   565   143.00 - 143.50    65.00 - 65.50     3.725   .376   136.27      4.353   .126   140.28  *
*   566   143.00 - 143.50    65.50 - 66.00     3.632   .428   137.73      4.320   .116   150.00  *
*   567   143.00 - 143.50    66.00 - 66.50     3.722   .328   164.93      4.422   .130   170.61  *
*   568   143.00 - 143.50    66.50 - 67.00     3.702   .339   187.74      4.275   .098   161.97  *
*   569   143.00 - 143.50    67.00 - 67.50     3.702   .339   211.66      4.219   .110   172.02  *
*   570   143.00 - 143.50    67.50 - 68.00     3.678   .356   240.66      4.196   .107   182.52  *
*   571   143.00 - 143.50    68.00 - 68.50     3.280   .000   255.23      3.926   .279   157.84  *
*   572   143.00 - 143.50    68.50 - 69.00      .000   .000      .00      3.855   .125   148.29  *
*   573   143.00 - 143.50    69.00 - 69.50      .000   .000      .00      3.750   .180   113.39  *
*   574   143.00 - 143.50    69.50 - 70.00      .000   .000      .00      3.737   .185    73.77  *
*   575   143.00 - 143.50    70.00 - 70.50      .000   .000      .00      3.554   .161    30.83  *
*   576   143.00 - 143.50    70.50 - 71.00      .000   .000      .00      3.461   .151    56.30  *
*   577   143.00 - 143.50    71.00 - 71.50      .000   .000      .00      3.387   .198    86.34  *
*   578   143.00 - 143.50    71.50 - 72.00      .000   .000      .00      3.321   .226   115.61  *
*   579   143.50 - 144.00    55.00 - 55.50     2.502   .000   199.49      3.449   .176   192.70  *
*   580   143.50 - 144.00    55.50 - 56.00     2.502   .000   183.97      3.783   .176   197.95  *
*   581   143.50 - 144.00    56.00 - 56.50     2.502   .000   173.99      4.410   .216   209.45  *
*   582   143.50 - 144.00    56.50 - 57.00     2.803   .000   196.02      4.933   .212   201.56  *
*   583   143.50 - 144.00    57.00 - 57.50     4.000   .704   293.58      5.175   .200   188.98  *
*   584   143.50 - 144.00    57.50 - 58.00     4.043   .663   259.37      5.228   .193   161.43  *
*   585   143.50 - 144.00    58.00 - 58.50     4.238   .517   236.06      5.127   .399   115.66  *
*   586   143.50 - 144.00    58.50 - 59.00     4.248   .509   201.47      5.142   .405    88.25  *
*   587   143.50 - 144.00    59.00 - 59.50     4.276   .484   172.27      5.146   .406    59.74  *
*   588   143.50 - 144.00    59.50 - 60.00     4.276   .484   139.79      5.148   .406    45.81  *
*   589   143.50 - 144.00    60.00 - 60.50     4.279   .481   111.26      5.150   .407    57.55  *
*   590   143.50 - 144.00    60.50 - 61.00     4.279   .481    78.21      5.153   .407    47.98  *
*   591   143.50 - 144.00    61.00 - 61.50     4.286   .475   124.33      5.275   .271    86.06  *
*   592   143.50 - 144.00    61.50 - 62.00     4.365   .456   163.98      5.274   .268   123.38  *
*   593   143.50 - 144.00    62.00 - 62.50     4.377   .444   171.82      5.228   .314   139.55  *
*   594   143.50 - 144.00    62.50 - 63.00     4.375   .446   153.23      5.199   .302   133.71  *
*   595   143.50 - 144.00    63.00 - 63.50     4.371   .450   102.78      4.991   .329   146.76  *
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*                              *    SEISMIC MAP OF ALASKA    *
*  GRID    LONG1 - LONG2       LAT1 - LAT2        A(H)   C(H)    R(H)        A(N)   C(N)    R(N)
*
*  596   143.50 - 144.00     63.50 - 64.00       4.079   .208   120.06       4.847   .142   126.80
*  597   143.50 - 144.00     64.00 - 64.50       3.960   .177   130.87       4.731   .105   143.55
*  598   143.50 - 144.00     64.50 - 65.00       3.824   .285   123.63       4.618   .087   143.71
*  599   143.50 - 144.00     65.00 - 65.50       3.802   .296   130.31       4.487   .118   139.22
*  600   143.50 - 144.00     65.50 - 66.00       3.722   .328   135.47       4.454   .122   149.16
*  601   143.50 - 144.00     66.00 - 66.50       3.722   .328   154.01       4.439   .119   161.28
*  602   143.50 - 144.00     66.50 - 67.00       3.702   .339   177.41       4.265   .090   145.25
*  603   143.50 - 144.00     67.00 - 67.50       3.702   .339   202.50       4.206   .103   162.29
*  604   143.50 - 144.00     67.50 - 68.00       3.678   .356   232.29       4.194   .107   175.45
*  605   143.50 - 144.00     68.00 - 68.50       3.280   .000   247.11       3.920   .277   151.70
*  606   143.50 - 144.00     68.50 - 69.00        .000   .000      .00       3.829   .123   139.99
*  607   143.50 - 144.00     69.00 - 69.50        .000   .000      .00       3.720   .168   104.41
*  608   143.50 - 144.00     69.50 - 70.00        .000   .000      .00       3.706   .173    64.96
*  609   143.50 - 144.00     70.00 - 70.50        .000   .000      .00       3.554   .161    19.83
*  610   143.50 - 144.00     70.50 - 71.00        .000   .000      .00       3.461   .151    50.52
*  611   143.50 - 144.00     71.00 - 71.50        .000   .000      .00       3.387   .198    81.54
*  612   143.50 - 144.00     71.50 - 72.00        .000   .000      .00       3.321   .226   112.48
*  613   144.00 - 144.50     55.00 - 55.50       2.502   .000   215.86       3.736   .187   204.03
*  614   144.00 - 144.50     55.50 - 56.00       2.502   .000   201.60       3.998   .195   203.48
*  615   144.00 - 144.50     56.00 - 56.50       2.502   .000   192.54       4.477   .216   204.71
*  616   144.00 - 144.50     56.50 - 57.00       2.979   .000   227.51       4.870   .313   177.33
*  617   144.00 - 144.50     57.00 - 57.50       4.013   .690   299.69       5.056   .377   157.27
*  618   144.00 - 144.50     57.50 - 58.00       4.159   .590   275.61       5.100   .392   127.81
*  619   144.00 - 144.50     58.00 - 58.50       4.235   .520   240.32       5.217   .319   118.24
*  620   144.00 - 144.50     58.50 - 59.00       4.245   .511   205.99       5.232   .324    91.06
*  621   144.00 - 144.50     59.00 - 59.50       4.273   .486   178.30       5.236   .325    60.99
*  622   144.00 - 144.50     59.50 - 60.00       4.273   .486   148.28       5.236   .324    36.54
*  623   144.00 - 144.50     60.00 - 60.50       4.276   .484   113.86       5.272   .273    60.26
*  624   144.00 - 144.50     60.50 - 61.00       4.276   .484    44.09       5.274   .272    59.80
*  625   144.00 - 144.50     61.00 - 61.50       4.302   .463   118.54       5.325   .247    94.67
*  626   144.00 - 144.50     61.50 - 62.00       4.388   .436   156.62       5.312   .237   121.10
*  627   144.00 - 144.50     62.00 - 62.50       4.399   .426   161.21       5.273   .263   138.02
*  628   144.00 - 144.50     62.50 - 63.00       4.399   .426   140.61       5.245   .251   148.30
*  629   144.00 - 144.50     63.00 - 63.50       4.396   .429    61.29       5.064   .237   145.91
*  630   144.00 - 144.50     63.50 - 64.00       4.116   .190   111.75       4.866   .143    91.13
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*                                  *     SEISMIC MAP OF ALASKA      *                               *
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*   GRID    LONG1  - LONG2      LAT1  - LAT2        A(H)    C(H)    R(H)        A(N)   C(N)    R(N)    *
**************************************************************************************************
*                                                                                                  *
*   631    144.00 - 144.50     64.00 - 64.50       4.002   .154   124.47       4.757   .103   132.10   *
*   632    144.00 - 144.50     64.50 - 65.00       3.824   .285   109.79       4.641   .077   130.82   *
*   633    144.00 - 144.50     65.00 - 65.50       3.802   .296   116.36       4.515   .114   127.93   *
*   634    144.00 - 144.50     65.50 - 66.00       3.722   .320   123.52       4.483   .114   138.37   *
*   635    144.00 - 144.50     66.00 - 66.50       3.722   .328   143.48       4.477   .115   152.88   *
*   636    144.00 - 144.50     66.50 - 67.00       3.702   .339   167.63       4.272   .088   116.18   *
*   637    144.00 - 144.50     67.00 - 67.50       3.702   .339   193.94       4.210   .101   151.73   *
*   638    144.00 - 144.50     67.50 - 68.00       3.676   .356   224.54       4.178   .104   166.21   *
*   639    144.00 - 144.50     68.00 - 68.50       3.280   .000   239.58       3.892   .272   142.35   *
*   640    144.00 - 144.50     68.50 - 69.00        .000   .000      .00       3.749   .109   125.53   *
*   641    144.00 - 144.50     69.00 - 69.50        .000   .000      .00       3.671   .192    94.58   *
*   642    144.00 - 144.50     69.50 - 70.00        .000   .000      .00       3.671   .192    59.70   *
*   643    144.00 - 144.50     70.00 - 70.50        .000   .000      .00       3.535   .166    18.89   *
*   644    144.00 - 144.50     70.50 - 71.00        .000   .000      .00       3.461   .151    46.59   *
*   645    144.00 - 144.50     71.00 - 71.50        .000   .000      .00       3.387   .198    77.80   *
*   646    144.00 - 144.50     71.50 - 72.00        .000   .000      .00       3.321   .226   110.50   *
*   647    144.50 - 145.00     55.00 - 55.50        .000   .000      .00       4.140   .265   207.90   *
*   648    144.50 - 145.00     55.50 - 56.00        .000   .000      .00       4.378   .226   206.44   *
*   649    144.50 - 145.00     56.00 - 56.50        .000   .000      .00       4.556   .262   180.45   *
*   650    144.50 - 145.00     56.50 - 57.00       2.803   .000   259.64       4.984   .259   180.60   *
*   651    144.50 - 145.00     57.00 - 57.50       4.000   .704   313.24       5.148   .302   160.00   *
*   652    144.50 - 145.00     57.50 - 58.00       4.153   .597   282.94       5.189   .312   108.48   *
*   653    144.50 - 145.00     58.00 - 58.50       4.254   .505   240.16       5.276   .280   112.95   *
*   654    144.50 - 145.00     58.50 - 59.00       4.263   .498   206.91       5.294   .285    86.38   *
*   655    144.50 - 145.00     59.00 - 59.50       4.293   .470   180.52       5.299   .285    49.16   *
*   656    144.50 - 145.00     59.50 - 60.00       4.293   .470   151.44       5.296   .283    31.51   *
*   657    144.50 - 145.00     60.00 - 60.50       4.295   .468   119.91       5.327   .250    51.69   *
*   658    144.50 - 145.00     60.50 - 61.00       4.295   .468    79.71       5.326   .248    56.22   *
*   659    144.50 - 145.00     61.00 - 61.50       4.323   .446   121.70       5.340   .250    89.14   *
*   660    144.50 - 145.00     61.50 - 62.00       4.403   .426   147.35       5.320   .237   114.08   *
*   661    144.50 - 145.00     62.00 - 62.50       4.414   .416   148.19       5.281   .264   130.37   *
*   662    144.50 - 145.00     62.50 - 63.00       4.414   .416   136.38       5.254   .252   142.06   *
*   663    144.50 - 145.00     63.00 - 63.50       4.410   .419    61.90       5.078   .238   132.97   *
*   664    144.50 - 145.00     63.50 - 64.00       4.213   .205   117.82       4.912   .159   117.24   *
*   665    144.50 - 145.00     64.00 - 64.50       4.028   .136   115.74       4.816   .121   124.74   *
*                                                                                                  *
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
666	144.50 - 145.00	64.50 - 65.00	3.830	.283	95.25	4.706	.082	120.63
667	144.50 - 145.00	65.00 - 65.50	3.802	.296	102.11	4.589	.092	121.02
668	144.50 - 145.00	65.50 - 66.00	3.722	.328	111.89	4.521	.115	126.27
669	144.50 - 145.00	66.00 - 66.50	3.722	.328	133.42	4.481	.115	142.42
670	144.50 - 145.00	66.50 - 67.00	3.702	.339	158.50	4.272	.088	82.79
671	144.50 - 145.00	67.00 - 67.50	3.702	.339	186.04	4.216	.101	142.96
672	144.50 - 145.00	67.50 - 68.00	3.678	.356	217.45	4.178	.101	155.23
673	144.50 - 145.00	68.00 - 68.50	3.280	.000	232.71	3.890	.271	132.34
674	144.50 - 145.00	68.50 - 69.00	.000	.000	.00	3.742	.101	118.08
675	144.50 - 145.00	69.00 - 69.50	.000	.000	.00	3.558	.175	80.29
676	144.50 - 145.00	69.50 - 70.00	.000	.000	.00	3.558	.175	50.20
677	144.50 - 145.00	70.00 - 70.50	.000	.000	.00	3.437	.157	26.02
678	144.50 - 145.00	70.50 - 71.00	.000	.000	.00	3.461	.151	39.30
679	144.50 - 145.00	71.00 - 71.50	.000	.000	.00	3.387	.198	75.40
680	144.50 - 145.00	71.50 - 72.00	.000	.000	.00	3.321	.226	109.79
681	145.00 - 145.50	55.00 - 55.50	.000	.000	.00	4.430	.256	218.10
682	145.00 - 145.50	55.50 - 56.00	.000	.000	.00	4.621	.240	209.79
683	145.00 - 145.50	56.00 - 56.50	.000	.000	.00	4.747	.235	185.90
684	145.00 - 145.50	56.50 - 57.00	2.803	.000	259.33	5.068	.241	178.66
685	145.00 - 145.50	57.00 - 57.50	4.043	.663	320.65	5.213	.269	159.42
686	145.00 - 145.50	57.50 - 58.00	4.177	.574	285.13	5.250	.276	134.56
687	145.00 - 145.50	58.00 - 58.50	4.282	.480	245.01	5.296	.287	117.67
688	145.00 - 145.50	58.50 - 59.00	4.290	.472	210.35	5.314	.291	88.71
689	145.00 - 145.50	59.00 - 59.50	4.314	.454	181.74	5.318	.291	46.44
690	145.00 - 145.50	59.50 - 60.00	4.314	.454	150.04	5.320	.290	37.38
691	145.00 - 145.50	60.00 - 60.50	4.319	.450	121.56	5.349	.256	44.37
692	145.00 - 145.50	60.50 - 61.00	4.319	.450	110.64	5.346	.254	49.47
693	145.00 - 145.50	61.00 - 61.50	4.384	.421	126.87	5.391	.236	78.32
694	145.00 - 145.50	61.50 - 62.00	4.447	.411	136.15	5.346	.246	106.07
695	145.00 - 145.50	62.00 - 62.50	4.457	.402	129.42	5.304	.272	120.43
696	145.00 - 145.50	62.50 - 63.00	4.457	.402	138.80	5.276	.258	127.46
697	145.00 - 145.50	63.00 - 63.50	4.454	.405	106.11	5.109	.250	111.82
698	145.00 - 145.50	63.50 - 64.00	4.213	.205	119.99	4.933	.168	117.89
699	145.00 - 145.50	64.00 - 64.50	4.028	.136	103.90	4.836	.130	112.28
700	145.00 - 145.50	64.50 - 65.00	3.830	.283	78.39	4.730	.093	106.46

SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
701	145.00 - 145.50	65.00 - 65.50	3.802	.296	87.74	4.605	.099	108.10
702	145.00 - 145.50	65.50 - 66.00	3.722	.328	100.75	4.534	.118	105.35
703	145.00 - 145.50	66.00 - 66.50	3.722	.328	123.94	4.483	.113	133.64
704	145.00 - 145.50	66.50 - 67.00	3.702	.339	150.10	4.274	.086	109.07
705	145.00 - 145.50	67.00 - 67.50	3.702	.339	178.88	4.211	.098	136.41
706	145.00 - 145.50	67.50 - 68.00	3.713	.333	209.53	4.181	.102	141.66
707	145.00 - 145.50	68.00 - 68.50	3.405	.000	239.44	3.892	.272	120.77
708	145.00 - 145.50	68.50 - 69.00	.000	.000	.00	3.738	.107	110.20
709	145.00 - 145.50	69.00 - 69.50	.000	.000	.00	3.537	.184	74.50
710	145.00 - 145.50	69.50 - 70.00	.000	.000	.00	3.537	.184	38.50
711	145.00 - 145.50	70.00 - 70.50	.000	.000	.00	3.411	.165	37.34
712	145.00 - 145.50	70.50 - 71.00	.000	.000	.00	3.437	.157	29.55
713	145.00 - 145.50	71.00 - 71.50	.000	.000	.00	3.356	.211	73.28
714	145.00 - 145.50	71.50 - 72.00	.000	.000	.00	3.321	.226	110.43
715	145.50 - 146.00	55.00 - 55.50	.000	.000	.00	4.578	.243	216.05
716	145.50 - 146.00	55.50 - 56.00	.000	.000	.00	4.708	.234	199.40
717	145.50 - 146.00	56.00 - 56.50	.000	.000	.00	4.812	.235	177.44
718	145.50 - 146.00	56.50 - 57.00	2.502	.000	240.31	5.099	.247	169.55
719	145.50 - 146.00	57.00 - 57.50	3.492	.298	233.65	5.235	.275	146.93
720	145.50 - 146.00	57.50 - 58.00	3.780	.289	217.39	5.270	.282	136.32
721	145.50 - 146.00	58.00 - 58.50	4.348	.451	246.32	5.362	.273	122.05
722	145.50 - 146.00	58.50 - 59.00	4.357	.442	211.67	5.376	.277	94.26
723	145.50 - 146.00	59.00 - 59.50	4.376	.428	181.96	5.387	.277	55.89
724	145.50 - 146.00	59.50 - 60.00	4.376	.428	146.12	5.388	.275	38.96
725	145.50 - 146.00	60.00 - 60.50	4.380	.424	102.56	5.412	.250	36.81
726	145.50 - 146.00	60.50 - 61.00	4.380	.424	118.16	5.406	.246	54.92
727	145.50 - 146.00	61.00 - 61.50	4.384	.421	118.55	5.412	.243	78.36
728	145.50 - 146.00	61.50 - 62.00	4.447	.411	117.37	5.363	.251	91.23
729	145.50 - 146.00	62.00 - 62.50	4.457	.402	91.29	5.319	.276	102.37
730	145.50 - 146.00	62.50 - 63.00	4.457	.402	134.73	5.290	.263	129.95
731	145.50 - 146.00	63.00 - 63.50	4.454	.405	139.93	5.124	.256	118.02
732	145.50 - 146.00	63.50 - 64.00	4.216	.203	122.19	4.949	.174	103.55
733	145.50 - 146.00	64.00 - 64.50	4.031	.134	91.55	4.858	.138	94.93
734	145.50 - 146.00	64.50 - 65.00	3.830	.283	58.67	4.754	.103	88.73
735	145.50 - 146.00	65.00 - 65.50	3.802	.296	73.89	4.632	.084	96.35

SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
736	145.50 - 146.00	65.50 - 66.00	3.722	.328	90.28	4.566	.092	80.74
737	145.50 - 146.00	66.00 - 66.50	3.747	.320	115.96	4.485	.113	126.74
738	145.50 - 146.00	66.50 - 67.00	3.731	.325	142.95	4.276	.088	120.94
739	145.50 - 146.00	67.00 - 67.50	3.731	.325	171.71	4.218	.099	130.21
740	145.50 - 146.00	67.50 - 68.00	3.713	.333	203.77	4.181	.102	121.97
741	145.50 - 146.00	68.00 - 68.50	3.405	.000	233.36	3.892	.272	106.67
742	145.50 - 146.00	68.50 - 69.00	.000	.000	.00	3.738	.107	101.11
743	145.50 - 146.00	69.00 - 69.50	.000	.000	.00	3.537	.184	72.35
744	145.50 - 146.00	69.50 - 70.00	.000	.000	.00	3.529	.195	26.95
745	145.50 - 146.00	70.00 - 70.50	.000	.000	.00	3.399	.181	46.28
746	145.50 - 146.00	70.50 - 71.00	.000	.000	.00	3.411	.165	40.79
747	145.50 - 146.00	71.00 - 71.50	.000	.000	.00	3.356	.211	76.92
748	145.50 - 146.00	71.50 - 72.00	.000	.000	.00	3.321	.226	112.39
749	146.00 - 146.50	55.00 - 55.50	.000	.000	.00	4.704	.297	199.53
750	146.00 - 146.50	55.50 - 56.00	.000	.000	.00	4.877	.248	196.77
751	146.00 - 146.50	56.00 - 56.50	.000	.000	.00	4.962	.241	176.87
752	146.00 - 146.50	56.50 - 57.00	2.502	.000	232.00	5.184	.246	165.41
753	146.00 - 146.50	57.00 - 57.50	3.492	.298	232.03	5.299	.263	117.70
754	146.00 - 146.50	57.50 - 58.00	3.926	.312	226.41	5.325	.263	136.10
755	146.00 - 146.50	58.00 - 58.50	4.090	.218	199.49	5.399	.286	120.53
756	146.00 - 146.50	58.50 - 59.00	4.107	.201	169.25	5.417	.290	97.28
757	146.00 - 146.50	59.00 - 59.50	4.142	.181	144.35	5.423	.290	66.38
758	146.00 - 146.50	59.50 - 60.00	4.142	.181	110.93	5.425	.288	36.84
759	146.00 - 146.50	60.00 - 60.50	4.149	.174	49.95	5.443	.261	31.28
760	146.00 - 146.50	60.50 - 61.00	4.149	.174	87.97	5.430	.253	57.37
761	146.00 - 146.50	61.00 - 61.50	4.389	.416	103.06	5.426	.246	71.77
762	146.00 - 146.50	61.50 - 62.00	4.452	.406	92.77	5.374	.254	84.01
763	146.00 - 146.50	62.00 - 62.50	4.461	.398	54.14	5.329	.279	107.03
764	146.00 - 146.50	62.50 - 63.00	4.461	.398	131.24	5.301	.267	122.67
765	146.00 - 146.50	63.00 - 63.50	4.455	.403	151.71	5.138	.261	103.88
766	146.00 - 146.50	63.50 - 64.00	4.247	.187	123.34	4.951	.174	78.83
767	146.00 - 146.50	64.00 - 64.50	4.075	.114	83.10	4.860	.138	71.68
768	146.00 - 146.50	64.50 - 65.00	3.900	.256	39.32	4.755	.103	64.49
769	146.00 - 146.50	65.00 - 65.50	3.877	.266	66.43	4.633	.084	82.40
770	146.00 - 146.50	65.50 - 66.00	3.817	.288	87.58	4.568	.092	96.19

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                              SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2    LAT1 - LAT2      A(H)   C(H)    R(H)        A(N)   C(N)    R(N)

   771   146.00 - 146.50   66.00 - 66.50   3.747   .320   107.96      4.485   .113   121.46
   772   146.00 - 146.50   66.50 - 67.00   3.731   .325   136.28      4.276   .088   119.07
   773   146.00 - 146.50   67.00 - 67.50   3.731   .325   166.12      4.219   .099   122.84
   774   146.00 - 146.50   67.50 - 68.00   3.713   .333   198.79      4.188   .101    91.37
   775   146.00 - 146.50   68.00 - 68.50   3.405   .000   228.05      3.906   .273    90.69
   776   146.00 - 146.50   68.50 - 69.00    .000   .000      .00      3.775   .106    92.63
   777   146.00 - 146.50   69.00 - 69.50    .000   .000      .00      3.546   .173    73.51
   778   146.00 - 146.50   69.50 - 70.00    .000   .000      .00      3.529   .195    40.16
   779   146.00 - 146.50   70.00 - 70.50    .000   .000      .00      3.399   .181    54.84
   780   146.00 - 146.50   70.50 - 71.00    .000   .000      .00      3.396   .181    57.31
   781   146.00 - 146.50   71.00 - 71.50    .000   .000      .00      3.356   .211    83.59
   782   146.00 - 146.50   71.50 - 72.00    .000   .000      .00      3.321   .226   115.51
   783   146.50 - 147.00   55.00 - 55.50    .000   .000      .00      4.812   .326   188.43
   784   146.50 - 147.00   55.50 - 56.00    .000   .000      .00      4.979   .254   185.90
   785   146.50 - 147.00   56.00 - 56.50    .000   .000      .00      5.045   .253   167.63
   786   146.50 - 147.00   56.50 - 57.00   2.502   .000   224.72      5.238   .259   159.01
   787   146.50 - 147.00   57.00 - 57.50   3.492   .296   230.65      5.340   .276   117.67
   788   146.50 - 147.00   57.50 - 58.00   3.926   .312   222.30      5.365   .277   133.23
   789   146.50 - 147.00   58.00 - 58.50   4.118   .201   192.08      5.473   .255   116.42
   790   146.50 - 147.00   58.50 - 59.00   4.133   .189   163.27      5.489   .258   102.03
   791   146.50 - 147.00   59.00 - 59.50   4.166   .166   138.82      5.495   .257    67.14
   792   146.50 - 147.00   59.50 - 60.00   4.166   .166   108.53      5.497   .256    40.67
   793   146.50 - 147.00   60.00 - 60.50   4.173   .160    77.33      5.473   .244    32.18
   794   146.50 - 147.00   60.50 - 61.00   4.173   .160    81.02      5.440   .254    54.46
   795   146.50 - 147.00   61.00 - 61.50   4.192   .147    65.29      5.458   .232    60.81
   796   146.50 - 147.00   61.50 - 62.00   4.305   .215    53.71      5.391   .259    73.81
   797   146.50 - 147.00   62.00 - 62.50   4.325   .197    75.26      5.344   .285    96.68
   798   146.50 - 147.00   62.50 - 63.00   4.325   .197   116.73      5.318   .273   107.01
   799   146.50 - 147.00   63.00 - 63.50   4.318   .203   134.04      5.154   .268   108.68
   800   146.50 - 147.00   63.50 - 64.00   4.247   .187   119.52      4.951   .174    67.18
   801   146.50 - 147.00   64.00 - 64.50   4.075   .114    75.49      4.859   .138    57.55
   802   146.50 - 147.00   64.50 - 65.00   3.900   .256    22.98      4.759   .103    40.45
   803   146.50 - 147.00   65.00 - 65.50   3.877   .266    56.99      4.637   .084    68.21
   804   146.50 - 147.00   65.50 - 66.00   3.617   .288    77.67      4.568   .092    97.45
   805   146.50 - 147.00   66.00 - 66.50   3.747   .320   100.93      4.489   .113   116.55
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                                SEISMIC MAP OF ALASKA

  GRID     LONG1 - LONG2      LAT1 - LAT2       A(H)    D(H)    R(H)        A(V)    D(V)    R(V)

  806     146.50 - 147.00    66.50 - 67.00     3.731   .325   130.65       4.283   .090   113.32
  807     146.50 - 147.00    67.00 - 67.50     3.731   .325   161.45       4.221   .100   116.41
  808     146.50 - 147.00    67.50 - 68.00     3.713   .333   194.64       4.189   .100    62.58
  809     146.50 - 147.00    68.00 - 68.50     3.405   .000   223.55       3.907   .272    67.64
  810     146.50 - 147.00    68.50 - 69.00      .000   .000      .00       3.779   .103    76.27
  811     146.50 - 147.00    69.00 - 69.50      .000   .000      .00       3.546   .173    74.82
  812     146.50 - 147.00    69.50 - 70.00      .000   .000      .00       3.529   .195    59.83
  813     146.50 - 147.00    70.00 - 70.50      .000   .000      .00       3.399   .181    64.26
  814     146.50 - 147.00    70.50 - 71.00      .000   .000      .00       3.396   .181    71.55
  815     146.50 - 147.00    71.00 - 71.50      .000   .000      .00       3.356   .211    91.85
  816     146.50 - 147.00    71.50 - 72.00      .000   .000      .00       3.321   .226   119.42
  817     147.00 - 147.50    55.00 - 55.50     2.802   .300   252.48       5.043   .268   193.46
  818     147.00 - 147.50    55.50 - 56.00     2.802   .300   230.29       5.140   .250   181.48
  819     147.00 - 147.50    56.00 - 56.50     2.802   .300   211.43       5.191   .243   163.82
  820     147.00 - 147.50    56.50 - 57.00     3.103   .001   201.98       5.341   .245   156.97
  821     147.00 - 147.50    57.00 - 57.50     3.585   .245   210.97       5.430   .254   143.57
  822     147.00 - 147.50    57.50 - 58.00     3.968   .283   211.72       5.450   .253   134.52
  823     147.00 - 147.50    58.00 - 58.50     4.118   .201   186.60       5.527   .253   123.52
  824     147.00 - 147.50    58.50 - 59.00     4.133   .189   157.35       5.542   .256   103.15
  825     147.00 - 147.50    59.00 - 59.50     4.166   .166   132.05       5.547   .254    67.81
  826     147.00 - 147.50    59.50 - 60.00     4.192   .154   105.22       5.542   .250    44.73
  827     147.00 - 147.50    60.00 - 60.50     4.199   .147    82.67       5.505   .234    37.28
  828     147.00 - 147.50    60.50 - 61.00     4.199   .147    73.14       5.471   .239    56.66
  829     147.00 - 147.50    61.00 - 61.50     4.192   .147    41.62       5.370   .313    45.48
  830     147.00 - 147.50    61.50 - 62.00     4.305   .215    64.99       5.388   .255    65.77
  831     147.00 - 147.50    62.00 - 62.50     4.325   .197    93.64       5.343   .282    72.70
  832     147.00 - 147.50    62.50 - 63.00     4.325   .197   120.86       5.314   .269    98.14
  833     147.00 - 147.50    63.00 - 63.50     4.318   .203   133.79       5.142   .259    98.09
  834     147.00 - 147.50    63.50 - 64.00     4.247   .187   114.49       4.951   .174    64.76
  835     147.00 - 147.50    64.00 - 64.50     4.075   .114    71.20       4.860   .138    55.67
  836     147.00 - 147.50    64.50 - 65.00     3.900   .256    36.43       4.756   .102    29.77
  837     147.00 - 147.50    65.00 - 65.50     3.877   .266    47.56       4.636   .085    53.94
  838     147.00 - 147.50    65.50 - 66.00     3.817   .288    68.18       4.572   .092    93.54
  839     147.00 - 147.50    66.00 - 66.50     3.747   .320    95.15       4.490   .112   110.62
  840     147.00 - 147.50    66.50 - 67.00     3.731   .325   126.21       4.284   .089   103.80
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
841	147.00 - 147.50	67.00 - 67.50	3.731	.325	157.77	4.222	.099	110.94
842	147.00 - 147.50	67.50 - 68.00	3.713	.333	191.34	4.186	.100	78.84
843	147.00 - 147.50	68.00 - 68.50	3.405	.000	219.88	3.907	.272	47.33
844	147.00 - 147.50	68.50 - 69.00	.000	.000	.00	3.779	.103	52.90
845	147.00 - 147.50	69.00 - 69.50	.000	.000	.00	3.588	.191	78.36
846	147.00 - 147.50	69.50 - 70.00	.000	.000	.00	3.572	.211	78.96
847	147.00 - 147.50	70.00 - 70.50	.000	.000	.00	3.458	.203	78.94
848	147.00 - 147.50	70.50 - 71.00	.000	.000	.00	3.399	.181	83.81
849	147.00 - 147.50	71.00 - 71.50	.000	.000	.00	3.356	.211	100.57
850	147.00 - 147.50	71.50 - 72.00	.000	.000	.00	3.321	.226	123.66
851	147.50 - 148.00	55.00 - 55.50	2.802	.300	239.39	5.146	.263	185.40
852	147.50 - 148.00	55.50 - 56.00	2.802	.300	215.86	5.229	.249	170.67
853	147.50 - 148.00	56.00 - 56.50	2.802	.300	195.61	5.269	.243	152.91
854	147.50 - 148.00	56.50 - 57.00	3.103	.001	189.37	5.404	.244	146.58
855	147.50 - 148.00	57.00 - 57.50	3.463	.116	193.85	5.489	.253	142.17
856	147.50 - 148.00	57.50 - 58.00	3.869	.242	192.88	5.507	.252	130.03
857	147.50 - 148.00	58.00 - 58.50	4.118	.201	181.44	5.449	.355	106.54
858	147.50 - 148.00	58.50 - 59.00	4.133	.189	151.71	5.456	.360	88.93
859	147.50 - 148.00	59.00 - 59.50	4.166	.166	124.98	5.460	.361	52.22
860	147.50 - 148.00	59.50 - 60.00	4.192	.154	95.54	5.454	.356	46.24
861	147.50 - 148.00	60.00 - 60.50	4.199	.147	63.41	5.419	.335	39.99
862	147.50 - 148.00	60.50 - 61.00	4.199	.147	63.82	5.389	.326	56.98
863	147.50 - 148.00	61.00 - 61.50	4.192	.147	33.01	5.378	.318	49.65
864	147.50 - 148.00	61.50 - 62.00	4.305	.215	50.77	5.397	.259	58.26
865	147.50 - 148.00	62.00 - 62.50	4.325	.197	97.75	5.351	.286	86.48
866	147.50 - 148.00	62.50 - 63.00	4.325	.197	123.02	5.319	.271	103.40
867	147.50 - 148.00	63.00 - 63.50	4.318	.203	132.82	5.147	.262	78.39
868	147.50 - 148.00	63.50 - 64.00	4.247	.187	108.92	4.933	.165	61.83
869	147.50 - 148.00	64.00 - 64.50	4.075	.114	60.34	4.860	.138	51.65
870	147.50 - 148.00	64.50 - 65.00	3.900	.256	43.12	4.756	.102	34.47
871	147.50 - 148.00	65.00 - 65.50	3.877	.266	32.10	4.638	.085	57.59
872	147.50 - 148.00	65.50 - 66.00	3.817	.288	60.15	4.574	.092	89.91
873	147.50 - 148.00	66.00 - 66.50	3.747	.320	91.03	4.490	.112	103.76
874	147.50 - 148.00	66.50 - 67.00	3.731	.325	123.09	4.284	.089	88.36
875	147.50 - 148.00	67.00 - 67.50	3.731	.325	155.13	4.222	.099	105.66

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                         *      SEISMIC MAP OF ALASKA       *

   GRID     LONG1 - LONG2      LAT1 - LAT2         A(H)    B(H)     R(H)         A(N)    B(N)      R(N)

    876    147.50 - 148.00    67.50 - 68.00       3.713    .333   188.93        4.198    .100     72.27
    877    147.50 - 148.00    68.00 - 68.50       3.405    .000   217.06        3.919    .274     66.79
    878    147.50 - 148.00    68.50 - 69.00        .000    .000      .00        3.812    .107     36.40
    879    147.50 - 148.00    69.00 - 69.50        .000    .000      .00        3.588    .191     79.85
    880    147.50 - 148.00    69.50 - 70.00        .000    .000      .00        3.572    .211     91.82
    881    147.50 - 148.00    70.00 - 70.50        .000    .000      .00        3.458    .203     89.94
    882    147.50 - 148.00    70.50 - 71.00        .000    .000      .00        3.399    .181     94.94
    883    147.50 - 148.00    71.00 - 71.50        .000    .000      .00        3.354    .211    109.15
    884    147.50 - 148.00    71.50 - 72.00        .000    .000      .00        3.321    .226    127.60
    885    148.00 - 148.50    55.00 - 55.50       2.802    .300   227.04        5.138    .275    165.07
    886    148.00 - 148.50    55.50 - 56.00       2.802    .300   202.08        5.197    .282    146.58
    887    148.00 - 148.50    56.00 - 56.50       2.802    .300   180.28        5.232    .286    126.38
    888    148.00 - 148.50    56.50 - 57.00       3.103    .001   176.65        5.335    .316    113.87
    889    148.00 - 148.50    57.00 - 57.50       3.463    .116   184.66        5.407    .342    117.52
    890    148.00 - 148.50    57.50 - 58.00       3.869    .242   186.41        5.422    .346    105.09
    891    148.00 - 148.50    58.00 - 58.50       4.036    .166   165.50        5.474    .363     98.49
    892    148.00 - 148.50    58.50 - 59.00       4.051    .157   136.65        5.485    .367     80.97
    893    148.00 - 148.50    59.00 - 59.50       4.092    .117   110.09        5.489    .368     58.32
    894    148.00 - 148.50    59.50 - 60.00       4.122    .096    80.58        5.474    .358     48.10
    895    148.00 - 148.50    60.00 - 60.50       4.129    .089    35.61        5.439    .338     46.76
    896    148.00 - 148.50    60.50 - 61.00       4.129    .089    51.43        5.399    .332     60.67
    897    148.00 - 148.50    61.00 - 61.50       4.192    .147    29.92        5.380    .319     67.83
    898    148.00 - 148.50    61.50 - 62.00       4.305    .215    64.74        5.399    .260     75.07
    899    148.00 - 148.50    62.00 - 62.50       4.325    .197    90.56        5.353    .286     94.33
    900    148.00 - 148.50    62.50 - 63.00       4.325    .197   123.25        5.321    .272     90.65
    901    148.00 - 148.50    63.00 - 63.50       4.318    .203   131.86        5.148    .262     72.18
    902    148.00 - 148.50    63.50 - 64.00       4.247    .187   104.74        4.931    .164     54.99
    903    148.00 - 148.50    64.00 - 64.50       4.075    .114    42.35        4.858    .138     53.89
    904    148.00 - 148.50    64.50 - 65.00       3.900    .256    34.21        4.754    .102     52.07
    905    148.00 - 148.50    65.00 - 65.50       3.877    .266    19.35        4.636    .083     65.59
    906    148.00 - 148.50    65.50 - 66.00       3.817    .288    56.28        4.574    .092     85.25
    907    148.00 - 148.50    66.00 - 66.50       3.747    .320    88.99        4.494    .113     96.70
    908    148.00 - 148.50    66.50 - 67.00       3.731    .325   121.37        4.289    .091     62.84
    909    148.00 - 148.50    67.00 - 67.50       3.731    .325   153.56        4.228    .101    101.12
    910    148.00 - 148.50    67.50 - 68.00       3.713    .333   187.41        4.198    .100     97.87
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                              SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)         A(N)    C(N)     R(N)

   511   148.00 - 148.50    68.00 - 68.50      3.405    .000   215.10        3.922    .275    86.52
   512   148.00 - 148.50    68.50 - 69.00       .000    .000      .00        3.812    .107    55.73
   513   148.00 - 148.50    69.00 - 69.50      2.502    .000   303.93        3.588    .191    65.49
   514   148.00 - 148.50    69.50 - 70.00       .000    .000      .00        3.572    .211   102.61
   515   148.00 - 148.50    70.00 - 70.50       .000    .000      .00        3.458    .203   100.73
   516   148.00 - 148.50    70.50 - 71.00       .000    .000      .00        3.399    .181   105.35
   517   148.00 - 148.50    71.00 - 71.50       .000    .000      .00        3.356    .211   117.29
   518   148.00 - 148.50    71.50 - 72.00       .000    .000      .00        3.321    .226   130.55
   519   148.50 - 149.00    55.00 - 55.50      2.802    .300   215.55        5.188    .286   155.90
   520   148.50 - 149.00    55.50 - 56.00      2.602    .300   189.08        5.241    .293   134.35
   521   148.50 - 149.00    56.00 - 56.50      2.802    .300   165.59        5.275    .297   103.17
   522   148.50 - 149.00    56.50 - 57.00      3.103    .001   163.73        5.370    .325    99.78
   523   148.50 - 149.00    57.00 - 57.50      3.463    .116   174.69        5.438    .350   104.43
   524   148.50 - 149.00    57.50 - 58.00      3.869    .242   179.85        5.452    .353    86.06
   525   148.50 - 149.00    58.00 - 58.50      4.036    .166   160.94        5.493    .361    83.43
   526   148.50 - 149.00    58.50 - 59.00      4.051    .157   132.34        5.504    .365    68.00
   527   148.50 - 149.00    59.00 - 59.50      4.092    .117   103.16        5.507    .365    65.28
   528   148.50 - 149.00    59.50 - 60.00      4.122    .096    68.78        5.490    .354    41.96
   529   148.50 - 149.00    60.00 - 60.50      4.129    .089    51.87        5.444    .333    50.79
   530   148.50 - 149.00    60.50 - 61.00      4.129    .089    38.44        5.395    .328    65.44
   531   148.50 - 149.00    61.00 - 61.50      4.122    .085    32.13        5.383    .321    71.57
   532   148.50 - 149.00    61.50 - 62.00      4.261    .181    61.45        5.402    .261    78.01
   533   148.50 - 149.00    62.00 - 62.50      4.282    .164    93.32        5.352    .286    85.74
   534   148.50 - 149.00    62.50 - 63.00      4.282    .164   117.41        5.319    .271    81.30
   535   148.50 - 149.00    63.00 - 63.50      4.274    .169   126.05        5.146    .262    66.72
   536   148.50 - 149.00    63.50 - 64.00      4.247    .187   103.65        4.931    .164    61.47
   537   148.50 - 149.00    64.00 - 64.50      4.075    .114    51.47        4.859    .138    64.94
   538   148.50 - 149.00    64.50 - 65.00      3.900    .256    22.22        4.756    .102    67.56
   539   148.50 - 149.00    65.00 - 65.50      3.677    .266    29.90        4.638    .084    61.65
   540   148.50 - 149.00    65.50 - 66.00      3.817    .288    57.93        4.577    .093    76.54
   541   148.50 - 149.00    66.00 - 66.50      3.747    .320    89.16        4.495    .113    90.25
   542   148.50 - 149.00    66.50 - 67.00      3.731    .325   121.05        4.290    .092    40.50
   543   148.50 - 149.00    67.00 - 67.50      3.731    .325   153.02        4.229    .102    99.31
   544   148.50 - 149.00    67.50 - 68.00      3.722    .328   185.44        4.199    .099   118.15
   545   148.50 - 149.00    68.00 - 68.50      3.456    .000   217.16        3.923    .274   100.67
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                          SEISMIC MAP OF ALASKA
   GRID     LONG1 - LONG2      LAT1 - LAT2      A(H)    B(H)    R(H)       A(N)    B(N)    R(N)

   546    148.50 - 149.00    68.50 - 69.00     2.502   .000   270.73      3.816   .102    84.37
   547    148.50 - 149.00    69.00 - 69.50     3.188   .521   308.04      3.588   .191    95.25
   548    148.50 - 149.00    69.50 - 70.00      .000   .000      .00      3.572   .211   112.57
   549    148.50 - 149.00    70.00 - 70.50      .000   .000      .00      3.458   .203   111.18
   550    148.50 - 149.00    70.50 - 71.00      .000   .000      .00      3.396   .181   115.25
   551    148.50 - 149.00    71.00 - 71.50      .000   .000      .00      3.356   .211   124.82
   552    148.50 - 149.00    71.50 - 72.00      .000   .000      .00      3.321   .226   131.68
   553    149.00 - 149.50    55.00 - 55.50     2.802   .300   205.08      5.230   .293   147.61
   554    149.00 - 149.50    55.50 - 56.00     2.802   .300   177.04      5.277   .302   121.70
   555    149.00 - 149.50    56.00 - 56.50     2.802   .300   151.70      5.309   .305    84.31
   556    149.00 - 149.50    56.50 - 57.00     3.103   .001   150.55      5.397   .329    98.90
   557    149.00 - 149.50    57.00 - 57.50     3.463   .116   163.34      5.462   .351    82.24
   558    149.00 - 149.50    57.50 - 58.00     3.869   .242   172.60      5.474   .354    79.90
   559    149.00 - 149.50    58.00 - 58.50     4.036   .166   156.76      5.499   .363    62.90
   560    149.00 - 149.50    58.50 - 59.00     4.051   .157   129.28      5.509   .367    61.19
   561    149.00 - 149.50    59.00 - 59.50     4.092   .117    98.96      5.512   .368    67.54
   562    149.00 - 149.50    59.50 - 60.00     4.122   .096    46.18      5.492   .355    45.13
   563    149.00 - 149.50    60.00 - 60.50     4.129   .089    55.16      5.445   .334    61.03
   564    149.00 - 149.50    60.50 - 61.00     4.129   .089    22.63      5.396   .329    64.14
   565    149.00 - 149.50    61.00 - 61.50     4.122   .085    28.10      5.377   .316    65.09
   566    149.00 - 149.50    61.50 - 62.00     4.261   .181    47.00      5.393   .256    78.83
   567    149.00 - 149.50    62.00 - 62.50     4.282   .164    89.55      5.342   .281    80.47
   568    149.00 - 149.50    62.50 - 63.00     4.282   .164   115.38      5.310   .267    71.03
   569    149.00 - 149.50    63.00 - 63.50     4.274   .169   126.21      5.145   .261    61.45
   570    149.00 - 149.50    63.50 - 64.00     4.250   .186   105.49      4.930   .163    62.10
   571    149.00 - 149.50    64.00 - 64.50     4.078   .112    42.58      4.860   .138    73.48
   572    149.00 - 149.50    64.50 - 65.00     3.906   .255    34.95      4.757   .102    67.96
   573    149.00 - 149.50    65.00 - 65.50     3.884   .263    32.41      4.639   .084    60.16
   574    149.00 - 149.50    65.50 - 66.00     3.824   .285    63.51      4.577   .093    59.33
   575    149.00 - 149.50    66.00 - 66.50     3.760   .318    91.94      4.495   .112    85.24
   576    149.00 - 149.50    66.50 - 67.00     3.739   .322   121.94      4.291   .092    62.14
   577    149.00 - 149.50    67.00 - 67.50     3.739   .322   152.70      4.230   .101   103.03
   578    149.00 - 149.50    67.50 - 68.00     3.838   .371   197.54      4.199   .099   128.31
   579    149.00 - 149.50    68.00 - 68.50     3.391   .427   180.36      3.923   .274   112.41
   580    149.00 - 149.50    68.50 - 69.00     3.188   .521   274.00      3.816   .102   107.08
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                          SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    B(H)    R(H)       A(N)    B(N)    R(N)

   981   149.00 - 149.50   69.00 - 69.50     3.188   .521   297.89      3.664   .155   114.41
   982   149.00 - 149.50   69.50 - 70.00      .000   .000      .00      3.600   .192   125.27
   983   149.00 - 149.50   70.00 - 70.50      .000   .000      .00      3.493   .179   125.02
   984   149.00 - 149.50   70.50 - 71.00      .000   .000      .00      3.399   .181   124.71
   985   149.00 - 149.50   71.00 - 71.50      .000   .000      .00      3.358   .211   131.62
   986   149.00 - 149.50   71.50 - 72.00      .000   .000      .00      3.321   .226   130.22
   987   149.50 - 150.00   55.00 - 55.50     2.802   .300   195.78      5.241   .295   137.10
   988   149.50 - 150.00   55.50 - 56.00     2.802   .300   166.18      5.292   .306   104.17
   989   149.50 - 150.00   56.00 - 56.50     2.802   .300   138.87      5.323   .309    63.40
   990   149.50 - 150.00   56.50 - 57.00     3.103   .001   137.18      5.403   .331    81.04
   991   149.50 - 150.00   57.00 - 57.50     3.463   .116   149.91      5.468   .354    66.97
   992   149.50 - 150.00   57.50 - 58.00     3.841   .250   160.83      5.479   .356    70.07
   993   149.50 - 150.00   58.00 - 58.50     4.036   .166   152.49      5.496   .363    45.90
   994   149.50 - 150.00   58.50 - 59.00     4.051   .157   127.43      5.509   .367    44.24
   995   149.50 - 150.00   59.00 - 59.50     4.092   .117    99.94      5.511   .367    65.62
   996   149.50 - 150.00   59.50 - 60.00     4.122   .096    67.01      5.490   .354    61.84
   997   149.50 - 150.00   60.00 - 60.50     4.129   .089    50.06      5.443   .332    66.30
   998   149.50 - 150.00   60.50 - 61.00     4.129   .089    37.44      5.393   .327    70.01
   999   149.50 - 150.00   61.00 - 61.50     4.125   .083    38.61      5.374   .315    63.45
  1000   149.50 - 150.00   61.50 - 62.00     4.264   .179    62.49      5.390   .255    67.25
  1001   149.50 - 150.00   62.00 - 62.50     4.284   .162    78.13      5.339   .279    76.45
  1002   149.50 - 150.00   62.50 - 63.00     4.284   .162   112.54      5.308   .266    68.39
  1003   149.50 - 150.00   63.00 - 63.50     4.277   .167   127.12      5.144   .261    43.24
  1004   149.50 - 150.00   63.50 - 64.00     4.255   .182   110.70      4.931   .164    52.64
  1005   149.50 - 150.00   64.00 - 64.50     4.085   .110    61.73      4.861   .138    82.29
  1006   149.50 - 150.00   64.50 - 65.00     3.915   .253    40.61      4.758   .102    75.51
  1007   149.50 - 150.00   65.00 - 65.50     3.895   .258    47.64      4.641   .084    43.24
  1008   149.50 - 150.00   65.50 - 66.00     3.836   .281    71.25      4.578   .092    39.44
  1009   149.50 - 150.00   66.00 - 66.50     3.874   .352   105.34      4.495   .112    82.01
  1010   149.50 - 150.00   66.50 - 67.00     3.854   .361   134.93      4.291   .092    84.64
  1011   149.50 - 150.00   67.00 - 67.50     3.854   .361   165.21      4.230   .101   110.14
  1012   149.50 - 150.00   67.50 - 68.00     3.638   .371   196.70      4.207   .098   135.23
  1013   149.50 - 150.00   68.00 - 68.50     3.391   .427   178.06      3.938   .278   122.41
  1014   149.50 - 150.00   68.50 - 69.00     3.188   .521   263.31      3.855   .100   127.92
  1015   149.50 - 150.00   69.00 - 69.50     3.188   .521   288.09      3.664   .155   126.81
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1016	149.50 - 150.00	69.50 - 70.00	.000	.000	.00	3.600	.192	135.16
1017	149.50 - 150.00	70.00 - 70.50	.000	.000	.00	3.493	.179	134.98
1018	149.50 - 150.00	70.50 - 71.00	.000	.000	.00	3.399	.181	133.83
1019	149.50 - 150.00	71.00 - 71.50	.000	.000	.00	3.356	.211	137.69
1020	149.50 - 150.00	71.50 - 72.00	.000	.000	.00	3.321	.226	125.86
1021	150.00 - 150.50	55.00 - 55.50	2.802	.300	187.83	5.247	.297	126.82
1022	150.00 - 150.50	55.50 - 56.00	2.802	.300	156.74	5.296	.307	105.91
1023	150.00 - 150.50	56.00 - 56.50	2.802	.300	127.42	5.325	.310	71.18
1024	150.00 - 150.50	56.50 - 57.00	3.103	.001	123.87	5.397	.329	80.35
1025	150.00 - 150.50	57.00 - 57.50	3.463	.116	133.75	5.461	.351	56.85
1026	150.00 - 150.50	57.50 - 58.00	3.841	.250	147.91	5.472	.353	56.53
1027	150.00 - 150.50	58.00 - 58.50	4.021	.164	145.98	5.499	.363	41.88
1028	150.00 - 150.50	58.50 - 59.00	4.037	.155	125.17	5.509	.368	46.17
1029	150.00 - 150.50	59.00 - 59.50	4.078	.117	101.38	5.509	.366	68.80
1030	150.00 - 150.50	59.50 - 60.00	4.112	.094	74.32	5.488	.353	73.78
1031	150.00 - 150.50	60.00 - 60.50	4.116	.091	33.90	5.440	.331	79.23
1032	150.00 - 150.50	60.50 - 61.00	4.116	.091	42.12	5.389	.325	77.32
1033	150.00 - 150.50	61.00 - 61.50	4.128	.080	30.82	5.371	.312	68.22
1034	150.00 - 150.50	61.50 - 62.00	4.267	.176	66.98	5.385	.252	62.31
1035	150.00 - 150.50	62.00 - 62.50	4.286	.161	54.62	5.334	.276	71.43
1036	150.00 - 150.50	62.50 - 63.00	4.286	.161	111.01	5.303	.263	67.14
1037	150.00 - 150.50	63.00 - 63.50	4.282	.164	128.57	5.138	.258	48.69
1038	150.00 - 150.50	63.50 - 64.00	4.300	.215	122.34	4.930	.164	60.37
1039	150.00 - 150.50	64.00 - 64.50	4.156	.172	81.57	4.861	.139	86.53
1040	150.00 - 150.50	64.50 - 65.00	4.002	.298	31.98	4.761	.104	76.95
1041	150.00 - 150.50	65.00 - 65.50	3.982	.307	65.59	4.642	.086	29.26
1042	150.00 - 150.50	65.50 - 66.00	3.933	.326	86.27	4.577	.093	35.75
1043	150.00 - 150.50	66.00 - 66.50	3.874	.352	109.36	4.500	.112	82.77
1044	150.00 - 150.50	66.50 - 67.00	3.854	.361	136.76	4.298	.096	96.32
1045	150.00 - 150.50	67.00 - 67.50	3.854	.361	165.67	4.237	.103	117.48
1046	150.00 - 150.50	67.50 - 68.00	3.838	.371	196.18	4.207	.098	140.77
1047	150.00 - 150.50	68.00 - 68.50	3.391	.427	175.92	3.936	.278	129.89
1048	150.00 - 150.50	68.50 - 69.00	3.188	.521	252.96	3.855	.100	141.18
1049	150.00 - 150.50	69.00 - 69.50	3.188	.521	278.66	3.664	.155	138.56
1050	150.00 - 150.50	69.50 - 70.00	.000	.000	.00	3.600	.192	145.02

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************************************************************************************************
*                        *     SEISMIC MAP OF ALASKA      *                                    *
************************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    C(H)     R(H)        A(N)    C(N)    R(N)    *
************************************************************************************************
*                                                                                              *
*  1051   150.00 - 150.50   70.00 - 70.50      .000    .000      .00        3.493   .179   144.67  *
*  1052   150.00 - 150.50   70.50 - 71.00      .000    .000      .00        3.399   .181   142.67  *
*  1053   150.00 - 150.5    71.00 - 71.50      .000    .000      .00        3.356   .211   143.21  *
*  1054   150.00 - 150.5    71.50 - 72.00      .000    .000      .00        3.321   .226   119.46  *
*  1055   150.50 - 151.00   55.00 - 55.50     2.602    .300    181.40       5.253   .299   109.44  *
*  1056   150.50 - 151.00   55.50 - 56.00     2.602    .300    148.98       5.302   .309   100.27  *
*  1057   150.50 - 151.00   56.00 - 56.50     2.802    .300    117.74       5.326   .311    75.29  *
*  1058   150.50 - 151.00   56.50 - 57.00     3.103    .001    111.26       5.394   .329    67.76  *
*  1059   150.50 - 151.00   57.00 - 57.50     3.463    .116    114.73       5.458   .351    55.57  *
*  1060   150.50 - 151.00   57.50 - 58.00     3.841    .250    128.43       5.467   .352    46.41  *
*  1061   150.50 - 151.00   58.00 - 58.50     4.025    .161    137.93       5.492   .360    43.90  *
*  1062   150.50 - 151.00   58.50 - 59.00     4.040    .154    123.88       5.501   .365    59.05  *
*  1063   150.50 - 151.00   59.00 - 59.50     4.082    .115    102.68       5.502   .363    74.44  *
*  1064   150.50 - 151.00   59.50 - 60.00     4.116    .091     77.93       5.479   .348    73.58  *
*  1065   150.50 - 151.00   60.00 - 60.50     4.119    .088     49.46       5.429   .326    77.52  *
*  1066   150.50 - 151.00   60.50 - 61.00     4.119    .088     30.66       5.378   .318    78.61  *
*  1067   150.50 - 151.00   61.00 - 61.50     4.111    .088     29.77       5.367   .311    62.16  *
*  1068   150.50 - 151.00   61.50 - 62.00     4.252    .186     62.60       5.379   .250    71.28  *
*  1069   150.50 - 151.00   62.00 - 62.50     4.272    .170     76.28       5.328   .274    70.28  *
*  1070   150.50 - 151.00   62.50 - 63.00     4.272    .170    111.60       5.296   .260    64.73  *
*  1071   150.50 - 151.00   63.00 - 63.50     4.312    .206    133.94       5.137   .258    47.39  *
*  1072   150.50 - 151.00   63.50 - 64.00     4.300    .215    128.93       4.922   .159    62.92  *
*  1073   150.50 - 151.00   64.00 - 64.50     4.156    .172     92.42       4.862   .139    88.55  *
*  1074   150.50 - 151.00   64.50 - 65.00     4.002    .298     51.80       4.764   .103    74.12  *
*  1075   150.50 - 151.00   65.00 - 65.50     3.982    .307     74.89       4.646   .087    45.51  *
*  1076   150.50 - 151.00   65.50 - 66.00     3.933    .326     92.90       4.581   .093    53.90  *
*  1077   150.50 - 151.00   66.00 - 66.50     3.874    .352    113.14       4.500   .112    88.07  *
*  1078   150.50 - 151.00   66.50 - 67.00     3.854    .361    138.70       4.298   .096   103.15  *
*  1079   150.50 - 151.00   67.00 - 67.50     3.854    .361    166.28       4.237   .103   123.58  *
*  1080   150.50 - 151.00   67.50 - 68.00     3.838    .371    195.82       4.207   .098   145.74  *
*  1081   150.50 - 151.00   68.00 - 68.50     3.391    .427    173.84       3.936   .278   135.90  *
*  1082   150.50 - 151.00   68.50 - 69.00     3.188    .521    243.00       3.855   .100   151.63  *
*  1083   150.50 - 151.00   69.00 - 69.50     3.188    .521    269.65       3.664   .155   149.37  *
*  1084   150.50 - 151.00   69.50 - 70.00      .000    .000      .00        3.600   .192   154.73  *
*  1085   150.50 - 151.00   70.00 - 70.50      .000    .000      .00        3.493   .179   154.12  *
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                      SEISMIC MAP OF ALASKA

GFID   LONG1 - LONG2    LAT1 - LAT2     A(H)   C(H)    R(H)      A(N)   C(N)    R(N)

1086  150.50 - 151.00  70.50 - 71.00    .000   .000     .00     3.411   .165  152.38
1087  150.50 - 151.00  71.00 - 71.50    .000   .000     .00     3.370   .192  149.98
1088  150.50 - 151.00  71.50 - 72.00    .000   .000     .00     3.321   .226  113.66
1089  151.00 - 151.50  55.00 - 55.50   2.953   .149  188.45     5.257   .301  114.30
1090  151.00 - 151.50  55.50 - 56.00   2.953   .149  155.73     5.306   .311   90.11
1091  151.00 - 151.50  56.00 - 56.50   2.953   .149  122.63     5.328   .312   64.81
1092  151.00 - 151.50  56.50 - 57.00   3.152   .049  103.11     5.392   .329   45.78
1093  151.00 - 151.50  57.00 - 57.50   3.492   .087   56.01     5.452   .349   46.29
1094  151.00 - 151.50  57.50 - 58.00   3.849   .245   99.17     5.459   .349   40.53
1095  151.00 - 151.50  58.00 - 58.50   4.025   .161  126.18     5.487   .360   39.82
1096  151.00 - 151.50  58.50 - 59.00   4.040   .154  122.53     5.495   .363   55.46
1097  151.00 - 151.50  59.00 - 59.50   4.082   .115  101.33     5.495   .361   62.92
1098  151.00 - 151.50  59.50 - 60.00   4.116   .091   77.71     5.472   .346   74.31
1099  151.00 - 151.50  60.00 - 60.50   4.119   .088   56.12     5.420   .322   65.87
1100  151.00 - 151.50  60.50 - 61.00   4.119   .088   20.61     5.367   .314   71.41
1101  151.00 - 151.50  61.00 - 61.50   4.108   .090   30.39     5.355   .304   55.39
1102  151.00 - 151.50  61.50 - 62.00   4.249   .188   48.81     5.363   .243   62.97
1103  151.00 - 151.50  62.00 - 62.50   4.270   .171   91.94     5.310   .265   54.06
1104  151.00 - 151.50  62.50 - 63.00   4.270   .171  112.37     5.279   .252   64.93
1105  151.00 - 151.50  63.00 - 63.50   4.309   .208  133.98     5.134   .257   45.98
1106  151.00 - 151.50  63.50 - 64.00   4.286   .228  132.96     4.919   .158   50.55
1107  151.00 - 151.50  64.00 - 64.50   4.153   .174  102.53     4.861   .138   56.21
1108  151.00 - 151.50  64.50 - 65.00   3.997   .300   72.23     4.762   .103   74.98
1109  151.00 - 151.50  65.00 - 65.50   3.977   .310   79.88     4.644   .086   59.61
1110  151.00 - 151.50  65.50 - 66.00   3.928   .329   95.89     4.579   .092   66.76
1111  151.00 - 151.50  66.00 - 66.50   3.874   .352  116.05     4.500   .112   76.25
1112  151.00 - 151.50  66.50 - 67.00   3.854   .361  140.37     4.298   .096  108.82
1113  151.00 - 151.50  67.00 - 67.50   3.854   .361  166.79     4.230   .100  128.17
1114  151.00 - 151.50  67.50 - 68.00   3.838   .371  195.44     4.207   .098  150.22
1115  151.00 - 151.50  68.00 - 68.50   3.391   .427  171.73     3.936   .278  140.82
1116  151.00 - 151.50  68.50 - 69.00   3.188   .521  233.48     3.854   .100  160.05
1117  151.00 - 151.50  69.00 - 69.50   3.188   .521  261.11     3.670   .147  159.23
1118  151.00 - 151.50  69.50 - 70.00    .000   .000     .00     3.608   .182  164.53
1119  151.00 - 151.50  70.00 - 70.50    .000   .000     .00     3.502   .167  153.76
1120  151.00 - 151.50  70.50 - 71.00    .000   .000     .00     3.411   .165  160.84
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
1121	151.00 - 151.50	71.00 - 71.50	.000	.000	.00	3.370	.192	155.55
1122	151.00 - 151.50	71.50 - 72.00	.000	.000	.00	3.321	.226	112.06
1123	151.50 - 152.00	55.00 - 55.50	2.953	.149	184.06	5.266	.304	110.52
1124	151.50 - 152.00	55.50 - 56.00	2.953	.149	150.91	5.313	.313	71.24
1125	151.50 - 152.00	56.00 - 56.50	2.953	.149	116.96	5.339	.315	37.80
1126	151.50 - 152.00	56.50 - 57.00	3.152	.049	95.33	5.390	.328	34.91
1127	151.50 - 152.00	57.00 - 57.50	3.463	.116	75.78	5.439	.343	39.44
1128	151.50 - 152.00	57.50 - 58.00	3.841	.250	58.89	5.446	.343	44.16
1129	151.50 - 152.00	58.00 - 58.50	4.025	.161	111.97	5.488	.357	44.84
1130	151.50 - 152.00	58.50 - 59.00	4.040	.154	121.81	5.495	.360	36.42
1131	151.50 - 152.00	59.00 - 59.50	4.082	.115	97.45	5.494	.358	64.52
1132	151.50 - 152.00	59.50 - 60.00	4.116	.091	62.72	5.465	.344	62.09
1133	151.50 - 152.00	60.00 - 60.50	4.119	.088	62.18	5.409	.317	60.15
1134	151.50 - 152.00	60.50 - 61.00	4.119	.088	37.65	5.359	.308	65.44
1135	151.50 - 152.00	61.00 - 61.50	4.108	.090	44.51	5.342	.298	69.88
1136	151.50 - 152.00	61.50 - 62.00	4.249	.188	69.73	5.346	.237	61.50
1137	151.50 - 152.00	62.00 - 62.50	4.270	.171	98.24	5.292	.259	66.37
1138	151.50 - 152.00	62.50 - 63.00	4.270	.171	104.46	5.265	.247	67.84
1139	151.50 - 152.00	63.00 - 63.50	4.309	.208	131.36	5.122	.252	61.92
1140	151.50 - 152.00	63.50 - 64.00	4.281	.230	137.42	4.915	.157	78.84
1141	151.50 - 152.00	64.00 - 64.50	4.150	.176	109.44	4.861	.138	98.52
1142	151.50 - 152.00	64.50 - 65.00	3.992	.302	77.20	4.762	.103	89.52
1143	151.50 - 152.00	65.00 - 65.50	3.971	.314	73.83	4.643	.086	71.72
1144	151.50 - 152.00	65.50 - 66.00	3.921	.333	94.21	4.579	.092	81.86
1145	151.50 - 152.00	66.00 - 66.50	3.868	.355	117.32	4.498	.111	104.52
1146	151.50 - 152.00	66.50 - 67.00	3.854	.361	141.46	4.294	.094	113.68
1147	151.50 - 152.00	67.00 - 67.50	3.854	.361	166.91	4.223	.098	132.05
1148	151.50 - 152.00	67.50 - 68.00	3.838	.371	194.87	4.206	.095	153.44
1149	151.50 - 152.00	68.00 - 68.50	3.391	.427	169.54	3.924	.275	143.97
1150	151.50 - 152.00	68.50 - 69.00	3.188	.521	224.45	3.822	.091	163.63
1151	151.50 - 152.00	69.00 - 69.50	3.188	.521	253.07	3.704	.162	171.56
1152	151.50 - 152.00	69.50 - 70.00	.000	.000	.00	3.645	.197	177.81
1153	151.50 - 152.00	70.00 - 70.50	.000	.000	.00	3.550	.186	178.76
1154	151.50 - 152.00	70.50 - 71.00	.000	.000	.00	3.469	.188	176.36
1155	151.50 - 152.00	71.00 - 71.50	.000	.000	.00	3.432	.214	169.86

SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1156	151.50 - 152.00	71.50 - 72.00	.000	.000	.00	3.321	.226	116.97
1157	152.00 - 152.50	55.00 - 55.50	2.953	.149	181.26	5.281	.308	108.35
1158	152.00 - 152.50	55.50 - 56.00	2.953	.149	148.16	5.327	.318	78.40
1159	152.00 - 152.50	56.00 - 56.50	2.953	.149	114.27	5.347	.319	47.16
1160	152.00 - 152.50	56.50 - 57.00	3.152	.049	92.22	5.395	.330	24.88
1161	152.00 - 152.50	57.00 - 57.50	3.463	.116	65.12	5.433	.339	36.57
1162	152.00 - 152.50	57.50 - 58.00	3.841	.250	28.87	5.439	.339	43.03
1163	152.00 - 152.50	58.00 - 58.50	4.021	.164	104.61	5.472	.350	48.12
1164	152.00 - 152.50	58.50 - 59.00	4.037	.155	123.26	5.480	.353	63.25
1165	152.00 - 152.50	59.00 - 59.50	4.040	.154	92.34	5.480	.351	71.21
1166	152.00 - 152.50	59.50 - 60.00	4.082	.115	35.63	5.448	.335	60.72
1167	152.00 - 152.50	60.00 - 60.50	4.085	.113	68.60	5.387	.307	50.60
1168	152.00 - 152.50	60.50 - 61.00	4.085	.113	56.64	5.331	.294	74.47
1169	152.00 - 152.50	61.00 - 61.50	4.108	.090	42.44	5.328	.291	76.00
1170	152.00 - 152.50	61.50 - 62.00	4.249	.188	86.11	5.327	.230	68.41
1171	152.00 - 152.50	62.00 - 62.50	4.270	.171	102.00	5.270	.250	82.46
1172	152.00 - 152.50	62.50 - 63.00	4.270	.171	76.77	5.243	.239	64.97
1173	152.00 - 152.50	63.00 - 63.50	4.309	.208	126.15	5.105	.245	32.52
1174	152.00 - 152.50	63.50 - 64.00	4.281	.230	141.31	4.899	.150	92.96
1175	152.00 - 152.50	64.00 - 64.50	4.150	.176	112.30	4.858	.138	108.23
1176	152.00 - 152.50	64.50 - 65.00	3.992	.302	63.36	4.761	.103	87.17
1177	152.00 - 152.50	65.00 - 65.50	3.971	.314	52.37	4.642	.086	65.59
1178	152.00 - 152.50	65.50 - 66.00	3.921	.333	89.93	4.578	.093	82.06
1179	152.00 - 152.50	66.00 - 66.50	3.861	.358	117.47	4.498	.111	111.48
1180	152.00 - 152.50	66.50 - 67.00	3.854	.361	141.64	4.294	.094	118.16
1181	152.00 - 152.50	67.00 - 67.50	3.854	.361	166.38	4.223	.098	135.53
1182	152.00 - 152.50	67.50 - 68.00	3.838	.371	193.93	4.198	.096	136.22
1183	152.00 - 152.50	68.00 - 68.50	3.391	.427	167.23	3.920	.274	146.96
1184	152.00 - 152.50	68.50 - 69.00	3.188	.521	215.98	3.810	.092	168.83
1185	152.00 - 152.50	69.00 - 69.50	3.188	.521	245.58	3.704	.162	179.62
1186	152.00 - 152.50	69.50 - 70.00	.000	.000	.00	3.645	.197	188.83
1187	152.00 - 152.50	70.00 - 70.50	.000	.000	.00	3.550	.186	192.23
1188	152.00 - 152.50	70.50 - 71.00	.000	.000	.00	3.469	.188	184.52
1189	152.00 - 152.50	71.00 - 71.50	.000	.000	.00	3.432	.214	177.09
1190	152.00 - 152.50	71.50 - 72.00	.000	.000	.00	3.321	.226	127.84

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                         SEISMIC MAP OF ALASKA
  GRID     LONG1 - LONG2      LAT1 - LAT2      A(H)    B(H)    R(H)        A(N)    B(N)    R(N)

  1191   152.50 - 153.00   55.00 - 55.50     2.953   .149   179.94       5.286   .309   106.28
  1192   152.50 - 153.00   55.50 - 56.00     2.953   .149   147.36       5.331   .319    75.51
  1193   152.50 - 153.00   56.00 - 56.50     2.953   .149   114.42       5.350   .320    35.78
  1194   152.50 - 153.00   56.50 - 57.00     3.152   .049    94.21       5.392   .329    28.11
  1195   152.50 - 153.00   57.00 - 57.50     3.463   .116    75.60       5.422   .336    39.36
  1196   152.50 - 153.00   57.50 - 58.00     3.841   .250    58.97       5.427   .335    55.31
  1197   152.50 - 153.00   58.00 - 58.50     4.021   .164   113.71       5.456   .345    46.94
  1198   152.50 - 153.00   58.50 - 59.00     4.033   .157   127.83       5.464   .348    68.32
  1199   152.50 - 153.00   59.00 - 59.50     4.037   .155   100.02       5.463   .344    69.34
  1200   152.50 - 153.00   59.50 - 60.00     4.078   .117    64.24       5.428   .328    50.36
  1201   152.50 - 153.00   60.00 - 60.50     4.082   .115    80.16       5.364   .298    39.90
  1202   152.50 - 153.00   60.50 - 61.00     4.082   .115    73.55       5.304   .283    74.26
  1203   152.50 - 153.00   61.00 - 61.50     4.073   .114    64.33       5.302   .277    82.83
  1204   152.50 - 153.00   61.50 - 62.00     4.223   .200    97.57       5.291   .214    95.18
  1205   152.50 - 153.00   62.00 - 62.50     4.245   .184   103.50       5.230   .231   101.06
  1206   152.50 - 153.00   62.50 - 63.00     4.245   .184    44.35       5.200   .219    89.11
  1207   152.50 - 153.00   63.00 - 63.50     4.287   .218   121.75       5.065   .226   100.55
  1208   152.50 - 153.00   63.50 - 64.00     4.281   .230   145.43       4.891   .146   104.45
  1209   152.50 - 153.00   64.00 - 64.50     4.150   .176   114.77       4.855   .138   117.02
  1210   152.50 - 153.00   64.50 - 65.00     3.992   .302    42.44       4.758   .102    86.46
  1211   152.50 - 153.00   65.00 - 65.50     3.971   .314    32.17       4.640   .084    79.62
  1212   152.50 - 153.00   65.50 - 66.00     3.921   .333    87.90       4.577   .092    98.02
  1213   152.50 - 153.00   66.00 - 66.50     3.861   .358   117.60       4.499   .112   114.85
  1214   152.50 - 153.00   66.50 - 67.00     3.854   .361   140.57       4.298   .096   121.33
  1215   152.50 - 153.00   67.00 - 67.50     3.854   .361   164.88       4.228   .100   137.70
  1216   152.50 - 153.00   67.50 - 68.00     3.838   .371   192.50       4.253   .100   154.77
  1217   152.50 - 153.00   68.00 - 68.50     3.391   .427   164.78       3.932   .277   148.83
  1218   152.50 - 153.00   68.50 - 69.00     3.188   .521   208.14       3.843   .103   174.51
  1219   152.50 - 153.00   69.00 - 69.50     3.188   .521   238.71       3.648   .160   181.33
  1220   152.50 - 153.00   69.50 - 70.00      .000   .000      .00       3.581   .200   193.80
  1221   152.50 - 153.00   70.00 - 70.50      .000   .000      .00       3.469   .188   198.43
  1222   152.50 - 153.00   70.50 - 71.00      .000   .000      .00       3.382   .175   188.71
  1223   152.50 - 153.00   71.00 - 71.50      .000   .000      .00       3.337   .206   178.90
  1224   152.50 - 153.00   71.50 - 72.00      .000   .000      .00       3.321   .226   142.41
  1225   153.00 - 153.50   55.00 - 55.50     2.953   .149   179.94       5.299   .312   105.91
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                         SEISMIC MAP OF ALASKA
  GRID   LONG1 - LONG2    LAT1 - LAT2      A(H)   C(H)    R(H)      A(N)   C(N)    R(N)

  1226   153.00 - 153.50  55.50 - 56.00   2.953   .149  148.16     5.343   .322   74.42
  1227   153.00 - 153.50  56.00 - 56.50   2.953   .149  116.80     5.358   .321   38.59
  1228   153.00 - 153.50  56.50 - 57.00   3.152   .049  100.11     5.396   .329   35.84
  1229   153.00 - 153.50  57.00 - 57.50   3.463   .116   92.73     5.421   .334   42.82
  1230   153.00 - 153.50  57.50 - 58.00   3.841   .250   99.31     5.420   .333   57.85
  1231   153.00 - 153.50  58.00 - 58.50   4.016   .167  131.39     5.439   .339   49.43
  1232   153.00 - 153.50  58.50 - 59.00   4.029   .159  135.72     5.444   .341   71.98
  1233   153.00 - 153.50  59.00 - 59.50   4.033   .157  113.85     5.444   .337   66.27
  1234   153.00 - 153.50  59.50 - 60.00   4.075   .120   94.87     5.407   .319   51.25
  1235   153.00 - 153.50  60.00 - 60.50   4.078   .117   94.73     5.338   .287   47.16
  1236   153.00 - 153.50  60.50 - 61.00   4.078   .117   89.65     5.274   .269   76.91
  1237   153.00 - 153.50  61.00 - 61.50   4.070   .115   86.45     5.272   .264  101.32
  1238   153.00 - 153.50  61.50 - 62.00   4.163   .162  105.72     5.248   .200  113.05
  1239   153.00 - 153.50  62.00 - 62.50   4.186   .149  106.57     5.182   .212  114.36
  1240   153.00 - 153.50  62.50 - 63.00   4.186   .149   72.39     5.149   .200  111.73
  1241   153.00 - 153.50  63.00 - 63.50   4.237   .189  123.39     5.016   .206  112.06
  1242   153.00 - 153.50  63.50 - 64.00   4.260   .237  147.88     4.887   .147  110.29
  1243   153.00 - 153.50  64.00 - 64.50   4.122   .186  118.78     4.854   .139  126.27
  1244   153.00 - 153.50  64.50 - 65.00   3.950   .320   63.22     4.758   .104  112.85
  1245   153.00 - 153.50  65.00 - 65.50   3.928   .329   51.10     4.642   .087  103.05
  1246   153.00 - 153.50  65.50 - 66.00   3.921   .333   92.41     4.579   .095   94.93
  1247   153.00 - 153.50  66.00 - 66.50   3.861   .358  116.92     4.532   .093  111.12
  1248   153.00 - 153.50  66.50 - 67.00   3.854   .361  137.67     4.342   .075  127.16
  1249   153.00 - 153.50  67.00 - 67.50   3.854   .361  162.15     4.276   .091  142.97
  1250   153.00 - 153.50  67.50 - 68.00   3.838   .371  190.50     4.251   .100  164.12
  1251   153.00 - 153.50  68.00 - 68.50   3.391   .427  162.24     3.929   .276  149.46
  1252   153.00 - 153.50  68.50 - 69.00   3.188   .521  200.99     3.835   .103  175.94
  1253   153.00 - 153.50  69.00 - 69.50   3.188   .521  232.50     3.642   .169  183.66
  1254   153.00 - 153.50  69.50 - 70.00    .000   .000     .00     3.572   .211  197.13
  1255   153.00 - 153.50  70.00 - 70.50    .000   .000     .00     3.469   .188  202.69
  1256   153.00 - 153.50  70.50 - 71.00    .000   .000     .00     3.257   .175  191.49
  1257   153.00 - 153.50  71.00 - 71.50    .000   .000     .00     3.195   .218  178.08
  1258   153.00 - 153.50  71.50 - 72.00    .000   .000     .00     3.195   .218  145.65
  1259   153.50 - 154.00  55.00 - 55.50   2.953   .149  181.03     5.300   .312  105.20
  1260   153.50 - 154.00  55.50 - 56.00   2.953   .149  150.10     5.343   .322   73.90
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
1261	153.50 - 154.00	56.00 - 56.50	2.953	.149	120.42	5.357	.322	32.71
1262	153.50 - 154.00	56.50 - 57.00	3.152	.049	107.46	5.392	.329	43.72
1263	153.50 - 154.00	57.00 - 57.50	3.342	.061	98.99	5.414	.333	44.93
1264	153.50 - 154.00	57.50 - 58.00	3.809	.264	126.49	5.412	.332	53.51
1265	153.50 - 154.00	58.00 - 58.50	3.999	.168	146.83	5.426	.333	61.40
1266	153.50 - 154.00	58.50 - 59.00	4.008	.161	143.99	5.430	.334	67.51
1267	153.50 - 154.00	59.00 - 59.50	4.013	.159	127.25	5.427	.329	57.99
1268	153.50 - 154.00	59.50 - 60.00	4.055	.126	114.99	5.388	.311	58.20
1269	153.50 - 154.00	60.00 - 60.50	4.059	.123	109.13	5.315	.276	52.05
1270	153.50 - 154.00	60.50 - 61.00	4.059	.123	104.43	5.247	.255	87.72
1271	153.50 - 154.00	61.00 - 61.50	4.067	.117	103.88	5.238	.248	112.35
1272	153.50 - 154.00	61.50 - 62.00	4.160	.165	119.16	5.193	.177	123.25
1273	153.50 - 154.00	62.00 - 62.50	4.183	.150	118.67	5.117	.184	122.95
1274	153.50 - 154.00	62.50 - 63.00	4.183	.150	106.18	5.080	.171	119.31
1275	153.50 - 154.00	63.00 - 63.50	4.235	.191	134.19	4.941	.172	113.30
1276	153.50 - 154.00	63.50 - 64.00	4.210	.208	147.97	4.877	.148	98.97
1277	153.50 - 154.00	64.00 - 64.50	4.042	.130	120.84	4.848	.146	135.77
1278	153.50 - 154.00	64.50 - 65.00	3.848	.279	80.27	4.758	.112	132.05
1279	153.50 - 154.00	65.00 - 65.50	3.830	.283	71.27	4.652	.078	120.65
1280	153.50 - 154.00	65.50 - 66.00	3.824	.285	91.87	4.591	.082	72.65
1281	153.50 - 154.00	66.00 - 66.50	3.861	.358	114.09	4.528	.094	88.56
1282	153.50 - 154.00	66.50 - 67.00	3.854	.361	132.22	4.338	.074	126.20
1283	153.50 - 154.00	67.00 - 67.50	3.854	.361	157.99	4.274	.091	137.16
1284	153.50 - 154.00	67.50 - 68.00	3.838	.371	187.93	4.243	.101	150.35
1285	153.50 - 154.00	68.00 - 68.50	3.391	.427	159.69	3.916	.274	148.63
1286	153.50 - 154.00	68.50 - 69.00	3.188	.521	194.61	3.797	.094	173.11
1287	153.50 - 154.00	69.00 - 69.50	3.188	.521	227.01	3.629	.175	184.36
1288	153.50 - 154.00	69.50 - 70.00	.000	.000	.00	3.551	.221	200.47
1289	153.50 - 154.00	70.00 - 70.50	.000	.000	.00	3.443	.199	207.80
1290	153.50 - 154.00	70.50 - 71.00	.000	.000	.00	3.257	.175	197.86
1291	153.50 - 154.00	71.00 - 71.50	.000	.000	.00	3.195	.218	186.52
1292	153.50 - 154.00	71.50 - 72.00	.000	.000	.00	2.981	.245	139.73
1293	154.00 - 154.50	55.00 - 55.50	2.953	.149	182.99	5.300	.312	103.05
1294	154.00 - 154.50	55.50 - 56.00	2.953	.149	152.70	5.341	.322	72.21
1295	154.00 - 154.50	56.00 - 56.50	2.953	.149	124.13	5.354	.322	40.66

SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
1296	154.00 - 154.50	56.50 - 57.00	3.152	.049	113.59	5.382	.327	39.34
1297	154.00 - 154.50	57.00 - 57.50	3.342	.061	110.13	5.402	.329	48.38
1298	154.00 - 154.50	57.50 - 58.00	3.809	.264	143.45	5.400	.327	68.71
1299	154.00 - 154.50	58.00 - 58.50	3.955	.181	155.39	5.419	.333	73.59
1300	154.00 - 154.50	58.50 - 59.00	3.965	.174	151.15	5.423	.333	65.97
1301	154.00 - 154.50	59.00 - 59.50	3.970	.171	138.27	5.420	.328	76.97
1302	154.00 - 154.50	59.50 - 60.00	4.015	.145	129.55	5.380	.310	75.82
1303	154.00 - 154.50	60.00 - 60.50	4.019	.142	121.87	5.304	.275	76.53
1304	154.00 - 154.50	60.50 - 61.00	4.019	.142	117.20	5.233	.251	89.45
1305	154.00 - 154.50	61.00 - 61.50	4.046	.126	118.00	5.207	.233	121.01
1306	154.00 - 154.50	61.50 - 62.00	4.142	.174	130.90	5.145	.160	131.40
1307	154.00 - 154.50	62.00 - 62.50	4.167	.158	128.38	5.061	.161	130.08
1308	154.00 - 154.50	62.50 - 63.00	4.167	.158	121.35	5.028	.150	108.31
1309	154.00 - 154.50	63.00 - 63.50	4.219	.201	139.80	4.884	.147	98.86
1310	154.00 - 154.50	63.50 - 64.00	4.207	.209	152.33	4.809	.117	120.02
1311	154.00 - 154.50	64.00 - 64.50	4.039	.131	130.63	4.783	.117	140.29
1312	154.00 - 154.50	64.50 - 65.00	3.848	.279	97.48	4.706	.096	139.84
1313	154.00 - 154.50	65.00 - 65.50	3.830	.283	89.85	4.594	.076	125.73
1314	154.00 - 154.50	65.50 - 66.00	3.824	.285	96.65	4.536	.089	97.72
1315	154.00 - 154.50	66.00 - 66.50	3.747	.320	96.18	4.512	.093	88.72
1316	154.00 - 154.50	66.50 - 67.00	3.739	.322	111.32	4.313	.072	123.53
1317	154.00 - 154.50	67.00 - 67.50	3.739	.322	138.01	4.251	.093	119.40
1318	154.00 - 154.50	67.50 - 68.00	3.838	.371	184.93	4.243	.101	153.89
1319	154.00 - 154.50	68.00 - 68.50	3.391	.427	157.26	3.916	.274	147.43
1320	154.00 - 154.50	68.50 - 69.00	3.188	.521	189.09	3.797	.094	172.43
1321	154.00 - 154.50	69.00 - 69.50	3.188	.521	222.28	3.603	.152	183.44
1322	154.00 - 154.50	69.50 - 70.00	.000	.000	.00	3.529	.195	203.58
1323	154.00 - 154.50	70.00 - 70.50	.000	.000	.00	3.411	.165	212.00
1324	154.00 - 154.50	70.50 - 71.00	.000	.000	.00	3.214	.194	205.45
1325	154.00 - 154.50	71.00 - 71.50	.000	.000	.00	3.140	.245	194.21
1326	154.00 - 154.50	71.50 - 72.00	.000	.000	.00	2.981	.245	154.95
1327	154.50 - 155.00	55.00 - 55.50	2.953	.149	185.66	5.302	.314	91.03
1328	154.50 - 155.00	55.50 - 56.00	2.953	.149	155.62	5.342	.323	66.93
1329	154.50 - 155.00	56.00 - 56.50	2.953	.149	127.14	5.354	.323	49.54
1330	154.50 - 155.00	56.50 - 57.00	3.103	.001	112.39	5.372	.325	53.23

SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
1231	154.50 - 155.00	57.00 - 57.50	3.302	.101	108.15	5.389	.326	67.65
1232	154.50 - 155.00	57.50 - 58.00	3.599	.234	120.85	5.385	.324	76.40
1233	154.50 - 155.00	58.00 - 58.50	3.949	.186	160.14	5.407	.329	72.25
1234	154.50 - 155.00	58.50 - 59.00	3.960	.177	160.38	5.410	.329	56.36
1235	154.50 - 155.00	59.00 - 59.50	3.965	.174	151.34	5.406	.324	90.81
1236	154.50 - 155.00	59.50 - 60.00	4.011	.149	145.05	5.365	.304	93.69
1237	154.50 - 155.00	60.00 - 60.50	4.015	.145	136.96	5.283	.268	94.06
1238	154.50 - 155.00	60.50 - 61.00	4.015	.145	132.22	5.209	.242	109.61
1239	154.50 - 155.00	61.00 - 61.50	3.998	.157	128.76	5.190	.230	130.83
1240	154.50 - 155.00	61.50 - 62.00	4.101	.201	139.63	5.120	.158	140.10
1241	154.50 - 155.00	62.00 - 62.50	4.112	.192	129.96	5.031	.154	137.86
1242	154.50 - 155.00	62.50 - 63.00	4.112	.192	113.75	5.000	.144	133.54
1243	154.50 - 155.00	63.00 - 63.50	4.164	.241	133.27	4.857	.138	125.02
1244	154.50 - 155.00	63.50 - 64.00	4.188	.224	152.47	4.744	.090	132.56
1245	154.50 - 155.00	64.00 - 64.50	4.014	.149	136.62	4.716	.086	144.40
1246	154.50 - 155.00	64.50 - 65.00	3.842	.280	110.11	4.652	.078	143.94
1247	154.50 - 155.00	65.00 - 65.50	3.830	.283	101.69	4.567	.078	128.67
1248	154.50 - 155.00	65.50 - 66.00	3.824	.285	95.44	4.502	.092	108.83
1249	154.50 - 155.00	66.00 - 66.50	3.754	.319	84.22	4.444	.113	111.16
1250	154.50 - 155.00	66.50 - 67.00	3.747	.320	100.72	4.206	.089	112.69
1251	154.50 - 155.00	67.00 - 67.50	3.747	.320	132.11	4.123	.140	76.32
1252	154.50 - 155.00	67.50 - 68.00	3.722	.328	165.07	4.225	.107	143.95
1253	154.50 - 155.00	68.00 - 68.50	3.391	.427	155.12	3.916	.274	145.93
1254	154.50 - 155.00	68.50 - 69.00	3.138	.521	184.49	3.797	.094	171.22
1255	154.50 - 155.00	69.00 - 69.50	3.188	.521	218.38	3.587	.175	174.65
1256	154.50 - 155.00	69.50 - 70.00	.000	.000	.00	3.535	.194	198.43
1257	154.50 - 155.00	70.00 - 70.50	.000	.000	.00	3.411	.165	211.76
1258	154.50 - 155.00	70.50 - 71.00	.000	.000	.00	3.104	.146	204.86
1259	154.50 - 155.00	71.00 - 71.50	.000	.000	.00	3.013	.205	192.62
1260	154.50 - 155.00	71.50 - 72.00	.000	.000	.00	2.881	.298	161.35
1261	155.00 - 155.50	55.00 - 55.50	2.953	.149	189.00	5.292	.313	95.22
1262	155.00 - 155.50	55.50 - 56.00	2.953	.149	158.80	5.321	.318	63.48
1263	155.00 - 155.50	56.00 - 56.50	2.953	.149	129.35	5.333	.317	64.40
1264	155.00 - 155.50	56.50 - 57.00	3.103	.001	111.87	5.346	.317	72.31
1265	155.00 - 155.50	57.00 - 57.50	3.302	.101	98.69	5.365	.319	75.33

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                            SEISMIC MAP OF ALASKA

 GFID    LONG1 - LONG2     LAT1 - LAT2        A(H)   D(H)    R(H)        A(N)   D(N)    R(N)

 1266   155.00 - 155.50   57.50 - 58.00      3.599   .234   101.07      5.360   .317    90.28
 1267   155.00 - 155.50   58.00 - 58.50      3.758   .135   134.09      5.392   .325    80.30
 1268   155.00 - 155.50   58.50 - 59.00      3.766   .127   148.44      5.393   .326    83.41
 1269   155.00 - 155.50   59.00 - 59.50      3.774   .120   146.27      5.389   .320   101.20
 1270   155.00 - 155.50   59.50 - 60.00      3.837   .087   144.67      5.345   .299   109.31
 1271   155.00 - 155.50   60.00 - 60.50      3.844   .078   137.60      5.259   .262   114.80
 1272   155.00 - 155.50   60.50 - 61.00      3.844   .078   132.90      5.176   .237   121.05
 1273   155.00 - 155.50   61.00 - 61.50      3.994   .160   142.42      5.163   .221   139.85
 1274   155.00 - 155.50   61.50 - 62.00      4.019   .142   140.26      5.079   .147   145.25
 1275   155.00 - 155.50   62.00 - 62.50      4.031   .134   120.77      4.985   .138   139.68
 1276   155.00 - 155.50   62.50 - 63.00      4.031   .134    77.62      4.951   .125   145.64
 1277   155.00 - 155.50   63.00 - 63.50      4.101   .201   111.59      4.830   .129   142.43
 1278   155.00 - 155.50   63.50 - 64.00      4.149   .253   148.12      4.728   .088   144.76
 1279   155.00 - 155.50   64.00 - 64.50      3.964   .185   141.23      4.702   .085   153.69
 1280   155.00 - 155.50   64.50 - 65.00      3.810   .291   119.60      4.636   .081   149.79
 1281   155.00 - 155.50   65.00 - 65.50      3.793   .301   106.61      4.548   .082   115.92
 1282   155.00 - 155.50   65.50 - 66.00      3.784   .307    86.11      4.479   .098    90.40
 1283   155.00 - 155.50   66.00 - 66.50      3.754   .319    66.11      4.402   .122   123.17
 1284   155.00 - 155.50   66.50 - 67.00      3.747   .320    87.74      4.135   .120   106.07
 1285   155.00 - 155.50   67.00 - 67.50      3.747   .320   125.98      4.030   .198    45.11
 1286   155.00 - 155.50   67.50 - 68.00      3.722   .328   162.12      4.128   .119   127.85
 1287   155.00 - 155.50   68.00 - 68.50      3.391   .427   153.47      3.967   .193   151.78
 1288   155.00 - 155.50   68.50 - 69.00      3.188   .521   180.88      3.717   .192   154.52
 1289   155.00 - 155.50   69.00 - 69.50      3.188   .521   215.34      3.574   .176   171.61
 1290   155.00 - 155.50   69.50 - 70.00       .000   .000      .00      3.518   .200   196.23
 1291   155.00 - 155.50   70.00 - 70.50       .000   .000      .00      3.382   .175   208.69
 1292   155.00 - 155.50   70.50 - 71.00       .000   .000      .00      3.104   .146   208.43
 1293   155.00 - 155.50   71.00 - 71.50       .000   .000      .00      3.013   .205   199.77
 1294   155.00 - 155.50   71.50 - 72.00       .000   .000      .00      2.621   .255   146.71
 1295   155.50 - 156.00   55.00 - 55.50      2.953   .149   193.07      5.280   .307    82.82
 1296   155.50 - 156.00   55.50 - 56.00      2.953   .149   162.45      5.298   .310    58.90
 1297   155.50 - 156.00   56.00 - 56.50      2.953   .149   131.49      5.309   .309    69.68
 1298   155.50 - 156.00   56.50 - 57.00      3.103   .001   110.20      5.325   .309    81.96
 1299   155.50 - 156.00   57.00 - 57.50      3.103   .001    69.37      5.341   .311    81.31
 1400   155.50 - 156.00   57.50 - 58.00      3.548   .245    59.27      5.336   .310    92.09
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*                           *       SEISMIC MAP OF ALASKA       *                           *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    C(H)    R(H)       A(N)   C(N)    R(N)   *
*********************************************************************************************
*                                                                                           *
*  1401   155.50 - 156.00   58.00 - 58.50     3.758   .135   120.99      5.365   .317   102.29  *
*  1402   155.50 - 156.00   58.50 - 59.00     3.766   .127   153.64      5.365   .317   108.90  *
*  1403   155.50 - 156.00   59.00 - 59.50     3.774   .120   157.11      5.360   .312   119.01  *
*  1404   155.50 - 156.00   59.50 - 60.00     3.837   .087   157.68      5.313   .290    98.37  *
*  1405   155.50 - 156.00   60.00 - 60.50     3.844   .078   150.93      5.206   .246   125.71  *
*  1406   155.50 - 156.00   60.50 - 61.00     3.844   .078   146.03      5.109   .228   110.91  *
*  1407   155.50 - 156.00   61.00 - 61.50     3.815   .096   139.59      5.130   .213   147.26  *
*  1408   155.50 - 156.00   61.50 - 62.00     3.850   .071   134.13      5.023   .162   143.80  *
*  1409   155.50 - 156.00   62.00 - 62.50     3.861   .059   105.28      4.917   .168   122.19  *
*  1410   155.50 - 156.00   62.50 - 63.00     3.861   .059    38.81      4.881   .152   146.18  *
*  1411   155.50 - 156.00   63.00 - 63.50     3.974   .177    72.01      4.809   .127   153.96  *
*  1412   155.50 - 156.00   63.50 - 64.00     4.085   .213   135.48      4.709   .087   153.89  *
*  1413   155.50 - 156.00   64.00 - 64.50     3.839   .079   132.60      4.686   .089   161.99  *
*  1414   155.50 - 156.00   64.50 - 65.00     3.664   .205   112.02      4.618   .086   155.10  *
*  1415   155.50 - 156.00   65.00 - 65.50     3.647   .208    95.53      4.530   .086    85.47  *
*  1416   155.50 - 156.00   65.50 - 66.00     3.637   .212    65.85      4.460   .106   105.17  *
*  1417   155.50 - 156.00   66.00 - 66.50     3.702   .339    41.79      4.388   .129   123.32  *
*  1418   155.50 - 156.00   66.50 - 67.00     3.691   .346    71.85      4.122   .121   105.11  *
*  1419   155.50 - 156.00   67.00 - 67.50     3.691   .346   116.43      4.060   .157    70.37  *
*  1420   155.50 - 156.00   67.50 - 68.00     3.722   .328   160.03      4.055   .159   120.85  *
*  1421   155.50 - 156.00   68.00 - 68.50     3.391   .427   152.51      3.952   .193   149.49  *
*  1422   155.50 - 156.00   68.50 - 69.00     3.188   .521   178.33      3.692   .178   150.88  *
*  1423   155.50 - 156.00   69.00 - 69.50     3.188   .521   213.20      3.561   .177   168.06  *
*  1424   155.50 - 156.00   69.50 - 70.00      .000   .000      .00      3.501   .206   193.75  *
*  1425   155.50 - 156.00   70.00 - 70.50      .000   .000      .00      3.350   .188   205.31  *
*  1426   155.50 - 156.00   70.50 - 71.00      .000   .000      .00      3.040   .175   204.05  *
*  1427   155.50 - 156.00   71.00 - 71.50      .000   .000      .00      3.013   .205   206.29  *
*  1428   155.50 - 156.00   71.50 - 72.00      .000   .000      .00      2.621   .255   160.07  *
*  1429   156.00 - 156.50   55.00 - 55.50     2.953   .149   197.99      5.268   .304    78.14  *
*  1430   156.00 - 156.50   55.50 - 56.00     2.953   .149   166.97      5.286   .306    84.26  *
*  1431   156.00 - 156.50   56.00 - 56.50     2.953   .149   134.70      5.298   .306    70.91  *
*  1432   156.00 - 156.50   56.50 - 57.00     3.103   .001   110.80      5.313   .305    82.39  *
*  1433   156.00 - 156.50   57.00 - 57.50     3.103   .001    63.48      5.330   .307    93.21  *
*  1434   156.00 - 156.50   57.50 - 58.00     3.532   .257    28.64      5.324   .306    86.83  *
*  1435   156.00 - 156.50   58.00 - 58.50     3.715   .154   110.40      5.341   .311   105.77  *
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*                       *     SEISMIC MAP OF ALASKA      *
  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)   B(H)    R(H)      A(N)   B(N)    R(N)

  1436   156.00 - 156.50   58.50 - 59.00      3.715   .154   157.52    5.338   .310   123.29
  1437   156.00 - 156.50   59.00 - 59.50      3.715   .154   167.56    5.332   .304   132.24
  1438   156.00 - 156.50   59.50 - 60.00      3.785   .135   171.94    5.279   .280   114.02
  1439   156.00 - 156.50   60.00 - 60.50      3.793   .123   165.21    5.158   .232   134.73
  1440   156.00 - 156.50   60.50 - 61.00      3.793   .123   159.93    5.048   .222   132.35
  1441   156.00 - 156.50   61.00 - 61.50      3.815   .096   151.22    5.052   .196   149.19
  1442   156.00 - 156.50   61.50 - 62.00      3.850   .071   143.32    4.879   .275   120.38
  1443   156.00 - 156.50   62.00 - 62.50      3.861   .059   113.25    4.816   .244    79.44
  1444   156.00 - 156.50   62.50 - 63.00      3.861   .059    65.29    4.779   .227   140.64
  1445   156.00 - 156.50   63.00 - 63.50      3.974   .177    43.70    4.699   .193   152.33
  1446   156.00 - 156.50   63.50 - 64.00      3.948   .197   119.13    4.691   .091   157.42
  1447   156.00 - 156.50   64.00 - 64.50      3.780   .130   132.88    4.674   .098   168.79
  1448   156.00 - 156.50   64.50 - 65.00      3.637   .212   115.68    4.613   .094   163.41
  1449   156.00 - 156.50   65.00 - 65.50      3.627   .217    95.35    4.525   .091   120.69
  1450   156.00 - 156.50   65.50 - 66.00      3.615   .225    57.68    4.454   .114    90.70
  1451   156.00 - 156.50   66.00 - 66.50      3.517   .268    20.35    4.365   .140   109.88
  1452   156.00 - 156.50   66.50 - 67.00      3.505   .270    52.51    4.093   .139   101.22
  1453   156.00 - 156.50   67.00 - 67.50      3.505   .270    94.42    4.030   .173    86.35
  1454   156.00 - 156.50   67.50 - 68.00      3.663   .368   155.58    4.060   .159   122.39
  1455   156.00 - 156.50   68.00 - 68.50      3.309   .434   149.17    3.955   .194   147.27
  1456   156.00 - 156.50   68.50 - 69.00      3.188   .521   176.88    3.692   .178   147.00
  1457   156.00 - 156.50   69.00 - 69.50      3.188   .521   211.99    3.524   .163   162.46
  1458   156.00 - 156.50   69.50 - 70.00       .000   .000      .00    3.457   .201   190.13
  1459   156.00 - 156.50   70.00 - 70.50       .000   .000      .00    3.257   .175   196.65
  1460   156.00 - 156.50   70.50 - 71.00       .000   .000      .00    2.954   .225   196.56
  1461   156.00 - 156.50   71.00 - 71.50       .000   .000      .00    2.922   .255   200.72
  1462   156.00 - 156.50   71.50 - 72.00       .000   .000      .00    2.621   .255   173.24
  1463   156.50 - 157.00   55.00 - 55.50      3.041   .061   193.18    5.260   .303    57.70
  1464   156.50 - 157.00   55.50 - 56.00      3.041   .061   170.89    5.275   .304    97.57
  1465   156.50 - 157.00   56.00 - 56.50      3.041   .061   144.29    5.282   .299    72.22
  1466   156.50 - 157.00   56.50 - 57.00      3.152   .049   119.08    5.279   .293    61.36
  1467   156.50 - 157.00   57.00 - 57.50      3.152   .049    74.28    5.294   .292   101.15
  1468   156.50 - 157.00   57.50 - 58.00      3.152   .049    40.22    5.286   .291   101.28
  1469   156.50 - 157.00   58.00 - 58.50      3.611   .226   111.40    5.326   .307    93.55
  1470   156.50 - 157.00   58.50 - 59.00      3.611   .226   154.33    5.323   .306   130.18
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*                        *     SEISMIC MAP OF ALASKA      *                                             *
*********************************************************************************************************
*  GRID    LONG1 - LONG2      LAT1 - LAT2         A(H)    C(H)    R(H)          A(N)    C(N)    R(N)    *
*********************************************************************************************************
*                                                                                                       *
*  1471   156.50 - 157.00    59.00 - 59.50       3.611   .226   167.80         5.317   .300   144.41    *
*  1472   156.50 - 157.00    59.50 - 60.00       3.715   .154   179.60         5.260   .275   136.16    *
*  1473   156.50 - 157.00    60.00 - 60.50       3.725   .144   174.22         5.127   .224   142.28    *
*  1474   156.50 - 157.00    60.50 - 61.00       3.725   .144   168.87         5.013   .208   146.83    *
*  1475   156.50 - 157.00    61.00 - 61.50       3.756   .151   162.31         4.985   .185   152.40    *
*  1476   156.50 - 157.00    61.50 - 62.00       3.765   .143   148.97         4.938   .128    98.96    *
*  1477   156.50 - 157.00    62.00 - 62.50       3.780   .130   121.70         4.862   .117    88.01    *
*  1478   156.50 - 157.00    62.50 - 63.00       3.780   .130    88.82         4.811   .115   157.51    *
*  1479   156.50 - 157.00    63.00 - 63.50       3.896   .242    70.36         4.702   .105   167.14    *
*  1480   156.50 - 157.00    63.50 - 64.00       3.948   .197   127.59         4.562   .132   128.58    *
*  1481   156.50 - 157.00    64.00 - 64.50       3.780   .130   137.99         4.546   .128   159.57    *
*  1482   156.50 - 157.00    64.50 - 65.00       3.637   .212   120.00         4.491   .120   159.15    *
*  1483   156.50 - 157.00    65.00 - 65.50       3.627   .217    96.89         4.398   .085   134.46    *
*  1484   156.50 - 157.00    65.50 - 66.00       3.615   .225    55.92         4.314   .071   103.27    *
*  1485   156.50 - 157.00    66.00 - 66.50       3.491   .275    14.97         4.362   .143    78.62    *
*  1486   156.50 - 157.00    66.50 - 67.00       3.475   .283    49.24         4.092   .140    96.59    *
*  1487   156.50 - 157.00    67.00 - 67.50       3.475   .283    91.79         4.032   .174    71.48    *
*  1488   156.50 - 157.00    67.50 - 68.00       3.475   .283   131.89         4.040   .173   118.84    *
*  1489   156.50 - 157.00    68.00 - 68.50       3.309   .434   149.47         3.932   .201   142.03    *
*  1490   156.50 - 157.00    68.50 - 69.00       3.188   .521   176.56         3.637   .151   136.98    *
*  1491   156.50 - 157.00    69.00 - 69.50       3.188   .521   211.72         3.524   .163   157.23    *
*  1492   156.50 - 157.00    69.50 - 70.00        .000   .000      .00         3.457   .201   185.61    *
*  1493   156.50 - 157.00    70.00 - 70.50        .000   .000      .00         3.257   .175   193.13    *
*  1494   156.50 - 157.00    70.50 - 71.00        .000   .000      .00         2.822   .122   184.42    *
*  1495   156.50 - 157.00    71.00 - 71.50        .000   .000      .00         2.822   .122   193.52    *
*  1496   156.50 - 157.00    71.50 - 72.00        .000   .000      .00         2.621   .255   186.21    *
*  1497   157.00 - 157.50    55.00 - 55.50       3.041   .061   191.47         5.237   .303    78.32    *
*  1498   157.00 - 157.50    55.50 - 56.00       3.041   .061   172.38         5.250   .301   101.92    *
*  1499   157.00 - 157.50    56.00 - 56.50       3.041   .061   149.16         5.255   .296    64.37    *
*  1500   157.00 - 157.50    56.50 - 57.00       3.152   .049   128.28         5.243   .282    54.59    *
*  1501   157.00 - 157.50    57.00 - 57.50       3.152   .049    92.20         5.257   .281    92.73    *
*  1502   157.00 - 157.50    57.50 - 58.00       3.152   .049    70.93         5.246   .277   119.65    *
*  1503   157.00 - 157.50    58.00 - 58.50       3.191   .089    94.43         5.281   .288   105.27    *
*  1504   157.00 - 157.50    58.50 - 59.00       3.152   .049   123.71         5.276   .288   114.72    *
*  1505   157.00 - 157.50    59.00 - 59.50       3.152   .049   146.23         5.264   .280   152.74    *
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                         SEISMIC MAP OF ALASKA

  GRID    LONG1  - LONG2     LAT1 - LAT2      A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

  1506   157.00 - 157.50   59.50 - 60.00    3.313   .039   170.05       5.194   .251   116.03
  1507   157.00 - 157.50   60.00 - 60.50    3.334   .049   168.46       5.031   .189   127.74
  1508   157.00 - 157.50   60.50 - 61.00    3.334   .049   162.48       4.884   .183   148.09
  1509   157.00 - 157.50   61.00 - 61.50    3.683   .168   168.94       4.954   .177   162.19
  1510   157.00 - 157.50   61.50 - 62.00    3.692   .160   154.17       4.906   .137   140.41
  1511   157.00 - 157.50   62.00 - 62.50    3.709   .150   131.08       4.829   .128   131.36
  1512   157.00 - 157.50   62.50 - 63.00    3.709   .150   106.26       4.774   .130   168.09
  1513   157.00 - 157.50   63.00 - 63.50    3.840   .259   104.27       4.662   .125   172.23
  1514   157.00 - 157.50   63.50 - 64.00    3.896   .242   139.47       4.501   .091    86.77
  1515   157.00 - 157.50   64.00 - 64.50    3.709   .199   139.07       4.479   .096   161.89
  1516   157.00 - 157.50   64.50 - 65.00    3.535   .327   115.04       4.403   .093   162.80
  1517   157.00 - 157.50   65.00 - 65.50    3.522   .331    91.69       4.307   .081   143.06
  1518   157.00 - 157.50   65.50 - 66.00    3.522   .331    55.54       4.190   .081   106.56
  1519   157.00 - 157.50   66.00 - 66.50    3.491   .275    25.58       4.217   .084    42.79
  1520   157.00 - 157.50   66.50 - 67.00    3.475   .283    53.61       4.041   .169    90.22
  1521   157.00 - 157.50   67.00 - 67.50    3.475   .283    94.35       4.018   .181    47.52
  1522   157.00 - 157.50   67.50 - 68.00    3.457   .295   132.74       4.050   .165   117.57
  1523   157.00 - 157.50   68.00 - 68.50    3.282   .447   148.99       3.944   .196   138.09
  1524   157.00 - 157.50   68.50 - 69.00    3.188   .521   177.37       3.637   .151   130.78
  1525   157.00 - 157.50   69.00 - 69.50    3.188   .521   212.39       3.454   .121   143.62
  1526   157.00 - 157.50   69.50 - 70.00     .000   .000      .00       3.382   .168   170.80
  1527   157.00 - 157.50   70.00 - 70.50     .000   .000      .00       3.295   .162   192.40
  1528   157.00 - 157.50   70.50 - 71.00     .000   .000      .00       2.822   .122   182.70
  1529   157.00 - 157.50   71.00 - 71.50     .000   .000      .00       2.822   .122   195.62
  1530   157.00 - 157.50   71.50 - 72.00     .000   .000      .00       2.071   .000   131.22
  1531   157.50 - 158.00   55.00 - 55.50    2.803   .000   168.17       5.158   .285    92.96
  1532   157.50 - 158.00   55.50 - 56.00    2.803   .000   154.77       5.172   .282    93.41
  1533   157.50 - 158.00   56.00 - 56.50    2.803   .000   136.86       5.174   .276    69.90
  1534   157.50 - 158.00   56.50 - 57.00    2.803   .000   112.30       5.159   .259    71.27
  1535   157.50 - 158.00   57.00 - 57.50    2.803   .000    86.90       5.173   .256    92.62
  1536   157.50 - 158.00   57.50 - 58.00    2.803   .000    75.10       5.156   .254   126.84
  1537   157.50 - 158.00   58.00 - 58.50    3.191   .089   115.83       5.239   .274   136.76
  1538   157.50 - 158.00   58.50 - 59.00    3.152   .049   137.27       5.230   .272   146.28
  1539   157.50 - 158.00   59.00 - 59.50    3.152   .049   157.43       5.218   .265   164.69
  1540   157.50 - 158.00   59.50 - 60.00    3.313   .039   180.54       5.139   .233   154.37
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                    *        SEISMIC MAP OF ALASKA        *

   GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)    B(H)     R(H)       A(N)    B(N)     R(N)

   1541   157.50 - 158.00   60.00 - 60.50    3.334    .049   177.87      4.953    .163   151.95
   1542   157.50 - 158.00   60.50 - 61.00    3.334    .049   171.52      4.807    .150   153.14
   1543   157.50 - 158.00   61.00 - 61.50    3.145    .272   134.60      4.838    .162   164.85
   1544   157.50 - 158.00   61.50 - 62.00    3.166    .286   116.44      4.790    .133   162.39
   1545   157.50 - 158.00   62.00 - 62.50    3.201    .314    97.64      4.712    .126   157.27
   1546   157.50 - 158.00   62.50 - 63.00    3.201    .314    81.41      4.661    .136   174.28
   1547   157.50 - 158.00   63.00 - 63.50    3.535    .327   102.80      4.512    .132   169.76
   1548   157.50 - 158.00   63.50 - 64.00    3.840    .259   149.46      4.444    .105   126.21
   1549   157.50 - 158.00   64.00 - 64.50    3.637    .212   136.38      4.420    .113   162.22
   1550   157.50 - 158.00   64.50 - 65.00    3.535    .327   119.29      4.354    .122   161.12
   1551   157.50 - 158.00   65.00 - 65.50    3.522    .331    97.03      4.252    .110   144.73
   1552   157.50 - 158.00   65.50 - 66.00    3.522    .331    65.22      4.125    .103   109.86
   1553   157.50 - 158.00   66.00 - 66.50    3.350    .425    37.38      4.043    .117    58.72
   1554   157.50 - 158.00   66.50 - 67.00    3.331    .428    54.71      3.814    .083    76.63
   1555   157.50 - 158.00   67.00 - 67.50    3.331    .428    86.96      3.780    .093    56.70
   1556   157.50 - 158.00   67.50 - 68.00    3.457    .295   136.76      4.033    .173   116.02
   1557   157.50 - 158.00   68.00 - 68.50    3.282    .447   151.74      3.928    .198   127.45
   1558   157.50 - 158.00   68.50 - 69.00    3.188    .521   179.30      3.604    .133   119.58
   1559   157.50 - 158.00   69.00 - 69.50    3.188    .521   214.01      3.458    .121   137.86
   1560   157.50 - 158.00   69.50 - 70.00     .000    .000      .00      3.382    .168   166.10
   1561   157.50 - 158.00   70.00 - 70.50     .000    .000      .00      3.295    .162   189.32
   1562   157.50 - 158.00   70.50 - 71.00     .000    .000      .00      2.822    .122   180.92
   1563   157.50 - 158.00   71.00 - 71.50     .000    .000      .00      2.822    .122   197.09
   1564   157.50 - 158.00   71.50 - 72.00     .000    .000      .00      2.071    .000   141.37
   1565   158.00 - 158.50   55.00 - 55.50    2.803    .000   156.85      5.107    .276    92.51
   1566   158.00 - 158.50   55.50 - 56.00    2.803    .000   148.93      5.121    .272    61.92
   1567   158.00 - 158.50   56.00 - 56.50    2.803    .000   138.79      5.121    .264    74.17
   1568   158.00 - 158.50   56.50 - 57.00    2.803    .000   122.72      5.092    .242    87.82
   1569   158.00 - 158.50   57.00 - 57.50    2.803    .000   105.15      5.086    .235   113.82
   1570   158.00 - 158.50   57.50 - 58.00    2.803    .000    97.53      5.056    .230   128.91
   1571   158.00 - 158.50   58.00 - 58.50    2.803    .000   107.71      5.142    .248   149.76
   1572   158.00 - 158.50   58.50 - 59.00    2.502    .000   101.41      5.128    .245   160.33
   1573   158.00 - 158.50   59.00 - 59.50    2.502    .000   127.42      5.112    .236   172.20
   1574   158.00 - 158.50   59.50 - 60.00    3.006    .258   193.29      5.000    .191   168.87
   1575   158.00 - 158.50   60.00 - 60.50    3.055    .245   184.80      4.846    .146   162.68
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*                     *          SEISMIC MAP OF ALASKA        *
*  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)   C(H)     R(H)        A(N)   C(N)    R(N)   *
*
*  1576   158.00 - 158.50    60.50 - 61.00      3.055   .245   170.31       4.719   .133   141.99  *
*  1577   158.00 - 158.50    61.00 - 61.50      3.145   .272   142.69       4.755   .137   170.76  *
*  1578   158.00 - 158.50    61.50 - 62.00      3.166   .286   125.58       4.681   .132   172.24  *
*  1579   158.00 - 158.50    62.00 - 62.50      3.201   .314   109.11       4.614   .123   168.95  *
*  1580   158.00 - 158.50    62.50 - 63.00      3.201   .314    95.58       4.563   .128   172.59  *
*  1581   158.00 - 158.50    63.00 - 63.50      3.535   .327   122.04       4.410   .132   167.76  *
*  1582   158.00 - 158.50    63.50 - 64.00      3.535   .327   126.53       4.224   .123   138.90  *
*  1583   158.00 - 158.50    64.00 - 64.50      3.535   .327   130.16       4.196   .134   143.05  *
*  1584   158.00 - 158.50    64.50 - 65.00      3.522   .331   122.75       4.170   .161   137.76  *
*  1585   158.00 - 158.50    65.00 - 65.50      3.522   .331   104.06       4.049   .133   124.64  *
*  1586   158.00 - 158.50    65.50 - 66.00      3.522   .331    77.83       3.998   .144   108.57  *
*  1587   158.00 - 158.50    66.00 - 66.50      3.350   .425    53.09       3.976   .104    83.71  *
*  1588   158.00 - 158.50    66.50 - 67.00      3.331   .428    65.79       3.811   .095    82.36  *
*  1589   158.00 - 158.50    67.00 - 67.50      3.331   .428    93.98       3.781   .101    74.10  *
*  1590   158.00 - 158.50    67.50 - 68.00      3.309   .434   124.61       3.837   .100    96.11  *
*  1591   158.00 - 158.50    68.00 - 68.50      3.282   .447   155.75       3.629   .153    84.24  *
*  1592   158.00 - 158.50    68.50 - 69.00      3.188   .521   182.31       3.516   .123   102.47  *
*  1593   158.00 - 158.50    69.00 - 69.50      3.245   .470   220.37       3.458   .121   132.39  *
*  1594   158.00 - 158.50    69.50 - 70.00       .000   .000      .00       3.382   .168   161.97  *
*  1595   158.00 - 158.50    70.00 - 70.50       .000   .000      .00       3.295   .162   186.73  *
*  1596   158.00 - 158.50    70.50 - 71.00       .000   .000      .00       2.822   .122   179.24  *
*  1597   158.00 - 158.50    71.00 - 71.50       .000   .000      .00       2.822   .122   198.12  *
*  1598   158.00 - 158.50    71.50 - 72.00       .000   .000      .00       2.071   .000   151.57  *
*  1599   158.50 - 159.00    55.00 - 55.50      3.041   .061   165.38       5.136   .265   112.42  *
*  1600   158.50 - 159.00    55.50 - 56.00      3.041   .061   165.20       5.153   .257    93.90  *
*  1601   158.50 - 159.00    56.00 - 56.50      2.803   .000   137.95       5.147   .249   107.81  *
*  1602   158.50 - 159.00    56.50 - 57.00      2.803   .000   131.27       5.099   .233   101.68  *
*  1603   158.50 - 159.00    57.00 - 57.50      2.803   .000   121.64       5.067   .234   132.25  *
*  1604   158.50 - 159.00    57.50 - 58.00      2.803   .000   118.01       5.019   .240   114.88  *
*  1605   158.50 - 159.00    58.00 - 58.50      2.803   .000   127.02       5.032   .222   156.19  *
*  1606   158.50 - 159.00    58.50 - 59.00      2.502   .000   115.47       5.011   .220   167.45  *
*  1607   158.50 - 159.00    59.00 - 59.50      2.502   .000   138.87       4.990   .209   180.17  *
*  1608   158.50 - 159.00    59.50 - 60.00      2.803   .000   189.34       4.857   .166   178.72  *
*  1609   158.50 - 159.00    60.00 - 60.50      2.979   .000   203.67       4.708   .145   168.54  *
*  1610   158.50 - 159.00    60.50 - 61.00      2.979   .000   189.91       4.541   .175    89.24  *
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                              SEISMIC MAP OF ALASKA

  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)    R(H)        A(N)    C(N)    R(N)

  1611    158.5  - 159.00    61.00 - 61.50      3.055   .245    156.75      4.688   .134   177.23
  1612    158.5  - 159.00    61.50 - 62.00      3.092   .249    135.82      4.593   .139   180.48
  1613    158.50 - 159.00    62.00 - 62.50      3.145   .272    119.14      4.527   .130   171.61
  1614    158.50 - 159.00    62.50 - 63.00      3.145   .272    105.63      4.468   .135   153.67
  1615    158.50 - 159.00    63.00 - 63.50      3.522   .331    136.27      4.288   .137   156.25
  1616    158.5  - 159.00    63.50 - 64.00      3.535   .327    134.85      4.049   .114   132.70
  1617    158.5  - 159.00    64.00 - 64.50      3.535   .327    133.43      4.046   .120   122.76
  1618    158.5  - 159.00    64.50 - 65.00      3.522   .331    126.66      4.024   .140   107.51
  1619    158.5  - 159.00    65.00 - 65.50      3.522   .331    112.00      3.968   .146   111.65
  1620    158.50 - 159.00    65.50 - 66.00      3.522   .331     91.57      3.938   .157   110.58
  1621    158.50 - 159.00    66.00 - 66.50      3.350   .425     68.47      3.862   .103    92.84
  1622    158.50 - 159.00    66.50 - 67.00      3.331   .428     78.22      3.829   .114    87.61
  1623    158.50 - 159.00    67.00 - 67.50      3.331   .428    102.66      3.816   .121    73.98
  1624    158.50 - 159.00    67.50 - 68.00      3.331   .428    131.66      3.832   .109    90.34
  1625    158.50 - 159.00    68.00 - 68.50      3.309   .434    161.10      3.626   .155    62.06
  1626    158.50 - 159.00    68.50 - 69.00      3.245   .470    190.20      3.516   .123    93.00
  1627    158.50 - 159.00    69.00 - 69.50      3.245   .470    222.83      3.458   .121   127.61
  1628    158.50 - 159.00    69.50 - 70.00       .000   .000       .00      3.382   .168   158.59
  1629    158.50 - 159.00    70.00 - 70.50       .000   .000       .00      3.295   .162   184.73
  1630    158.50 - 159.00    70.50 - 71.00       .000   .000       .00      2.822   .122   177.78
  1631    158.50 - 159.00    71.00 - 71.50       .000   .000       .00      2.822   .122   198.89
  1632    158.50 - 159.00    71.50 - 72.00       .000   .000       .00      2.071   .000   161.80
  1633    159.00 - 159.50    54.00 - 54.50      2.953   .149    157.70      4.967   .266    98.02
  1634    159.00 - 159.50    54.50 - 55.00      3.103   .001    152.51      5.085   .263    81.80
  1635    159.00 - 159.50    55.00 - 55.50      3.103   .001    148.13      5.093   .257   107.71
  1636    159.00 - 159.50    55.50 - 56.00      3.103   .001    152.97      5.109   .252   115.84
  1637    159.00 - 159.50    56.00 - 56.50      2.979   .000    151.28      5.093   .246   103.36
  1638    159.00 - 159.50    56.50 - 57.00      2.979   .000    155.84      5.029   .234   113.58
  1639    159.00 - 159.50    57.00 - 57.50      2.979   .000    155.61      4.976   .235   137.32
  1640    159.00 - 159.50    57.50 - 58.00      2.803   .000    135.79      4.881   .238   139.00
  1641    159.00 - 159.50    58.00 - 58.50      2.803   .000    144.93      4.979   .233   168.80
  1642    159.00 - 159.50    58.50 - 59.00      2.502   .000    130.62      4.950   .239   166.45
  1643    159.00 - 159.50    59.00 - 59.50      2.502   .000    151.70      4.917   .230   192.79
  1644    159.00 - 159.50    59.50 - 60.00      2.803   .000    199.48      4.737   .191   188.89
  1645    159.00 - 159.50    60.00 - 60.50      2.979   .000    211.67      4.545   .157   170.72
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                         SEISMIC MAP OF ALASKA

 GRID    LONG1 - LONG2     LAT1 - LAT2       A(H)    O(H)     R(H)        A(N)    O(N)     R(N)

 1646   159.00 - 159.50   60.50 - 61.00     2.979   .000    198.41       4.409   .162    128.48
 1647   159.00 - 159.50   61.00 - 61.50     2.979   .000    172.79       4.493   .185    172.65
 1648   159.00 - 159.50   61.50 - 62.00     2.979   .000    147.04       4.389   .181    171.40
 1649   159.00 - 159.50   62.00 - 62.50     2.979   .000    125.98       4.298   .150    145.97
 1650   159.00 - 159.50   62.50 - 63.00     2.979   .000    111.13       4.218   .132     87.75
 1651   159.00 - 159.50   63.00 - 63.50     3.309   .434    129.15       4.020   .187    119.49
 1652   159.00 - 159.50   63.50 - 64.00     3.522   .331    138.03       3.889   .110    119.19
 1653   159.00 - 159.50   64.00 - 64.50     3.522   .331    132.13       3.890   .117     97.46
 1654   159.00 - 159.50   64.50 - 65.00     3.522   .331    128.88       3.878   .123     71.87
 1655   159.00 - 159.50   65.00 - 65.50     3.522   .331    119.92       3.880   .118     93.91
 1656   159.00 - 159.50   65.50 - 66.00     3.522   .331    105.33       3.855   .117    106.06
 1657   159.00 - 159.50   66.00 - 66.50     3.379   .425     84.54       3.835   .112    100.03
 1658   159.00 - 159.50   66.50 - 67.00     3.365   .424     92.86       3.827   .119     86.48
 1659   159.00 - 159.50   67.00 - 67.50     3.365   .424    113.73       3.814   .126     53.31
 1660   159.00 - 159.50   67.50 - 68.00     3.331   .428    138.75       3.816   .121     82.11
 1661   159.00 - 159.50   68.00 - 68.50     3.309   .434    166.47       3.612   .154     41.52
 1662   159.00 - 159.50   68.50 - 69.00     3.245   .470    194.18       3.510   .130     84.78
 1663   159.00 - 159.50   69.00 - 69.50     3.245   .470    225.92       3.458   .121    123.98
 1664   159.00 - 159.50   69.50 - 70.00      .000   .000       .00       3.382   .168    156.10
 1665   159.00 - 159.50   70.00 - 70.50      .000   .000       .00       3.295   .162    183.38
 1666   159.00 - 159.50   70.50 - 71.00      .000   .000       .00       2.822   .122    176.65
 1667   159.00 - 159.50   71.00 - 71.50      .000   .000       .00       2.822   .122    199.55
 1668   159.00 - 159.50   71.50 - 72.00      .000   .000       .00       2.071   .000    172.07
 1669   159.50 - 160.00   54.00 - 54.50     3.041   .061    141.29       4.982   .264     82.52
 1670   159.50 - 160.00   54.50 - 55.00     3.152   .049    135.06       5.042   .250     84.82
 1671   159.50 - 160.00   55.00 - 55.50     3.152   .049    129.64       5.049   .247     75.33
 1672   159.50 - 160.00   55.50 - 56.00     3.152   .049    138.64       5.061   .246    111.58
 1673   159.50 - 160.00   56.00 - 56.50     3.104   .000    156.52       5.042   .239    101.81
 1674   159.50 - 160.00   56.50 - 57.00     2.979   .000    156.17       4.948   .263     80.42
 1675   159.50 - 160.00   57.00 - 57.50     2.979   .000    164.94       4.872   .252    136.34
 1676   159.50 - 160.00   57.50 - 58.00     2.803   .000    150.47       4.715   .289    141.40
 1677   159.50 - 160.00   58.00 - 58.50     2.803   .000    160.88       4.827   .231    168.02
 1678   159.50 - 160.00   58.50 - 59.00     2.502   .000    146.52       4.784   .240    110.40
 1679   159.50 - 160.00   59.00 - 59.50     2.502   .000    165.59       4.729   .228    188.54
 1680   159.50 - 160.00   59.50 - 60.00     2.803   .000    210.56       4.546   .186    190.29
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	O(H)	R(H)	A(N)	O(N)	R(N)
1681	159.50 - 160.00	60.00 - 60.50	2.979	.000	220.61	4.213	.223	154.61
1682	159.50 - 160.00	60.50 - 61.00	2.979	.000	207.81	4.160	.200	146.01
1683	159.50 - 160.00	61.00 - 61.50	2.979	.000	181.15	4.321	.175	171.60
1684	159.50 - 160.00	61.50 - 62.00	2.979	.000	156.55	4.289	.176	172.94
1685	159.50 - 160.00	62.00 - 62.50	2.979	.000	136.04	4.173	.155	132.63
1686	159.50 - 160.00	62.50 - 63.00	2.979	.000	120.07	4.080	.149	43.87
1687	159.50 - 160.00	63.00 - 63.50	3.309	.434	134.01	3.975	.161	112.20
1688	159.50 - 160.00	63.50 - 64.00	3.350	.425	118.54	3.856	.138	116.77
1689	159.50 - 160.00	64.00 - 64.50	3.350	.425	108.43	3.864	.131	84.98
1690	159.50 - 160.00	64.50 - 65.00	3.350	.425	110.39	3.864	.131	43.31
1691	159.50 - 160.00	65.00 - 65.50	3.350	.425	109.29	3.867	.126	83.31
1692	159.50 - 160.00	65.50 - 66.00	3.350	.425	101.21	3.840	.127	106.38
1693	159.50 - 160.00	66.00 - 66.50	3.379	.425	97.93	3.827	.127	103.80
1694	159.50 - 160.00	66.50 - 67.00	3.365	.424	105.21	3.821	.130	83.90
1695	159.50 - 160.00	67.00 - 67.50	3.365	.424	123.31	3.808	.138	33.69
1696	159.50 - 160.00	67.50 - 68.00	3.331	.428	146.49	3.814	.126	77.21
1697	159.50 - 160.00	68.00 - 68.50	3.309	.434	172.46	3.608	.157	41.39
1698	159.50 - 160.00	68.50 - 69.00	3.245	.470	198.75	3.510	.130	79.94
1699	159.50 - 160.00	69.00 - 69.50	3.245	.470	229.56	3.451	.132	121.44
1700	159.50 - 160.00	69.50 - 70.00	.000	.000	.00	3.372	.184	154.23
1701	159.50 - 160.00	70.00 - 70.50	.000	.000	.00	3.280	.183	183.00
1702	159.50 - 160.00	70.50 - 71.00	.000	.000	.00	2.822	.122	175.94
1703	159.50 - 160.00	71.00 - 71.50	.000	.000	.00	2.822	.122	200.24
1704	159.50 - 160.00	71.50 - 72.00	.000	.000	.00	2.071	.000	182.37
1705	160.00 - 160.50	54.00 - 54.50	3.103	.001	127.36	5.005	.251	97.56
1706	160.00 - 160.50	54.50 - 55.00	3.152	.049	113.84	5.041	.253	99.63
1707	160.00 - 160.50	55.00 - 55.50	3.152	.049	104.16	5.046	.252	65.36
1708	160.00 - 160.50	55.50 - 56.00	3.152	.049	117.64	5.046	.249	89.77
1709	160.00 - 160.50	56.00 - 56.50	3.104	.000	143.57	5.023	.244	111.70
1710	160.00 - 160.50	56.50 - 57.00	2.979	.000	153.34	4.927	.263	116.40
1711	160.00 - 160.50	57.00 - 57.50	2.979	.000	170.33	4.824	.248	142.58
1712	160.00 - 160.50	57.50 - 58.00	2.803	.000	162.12	4.644	.281	148.89
1713	160.00 - 160.50	58.00 - 58.50	2.803	.000	174.72	4.642	.264	161.03
1714	160.00 - 160.50	58.50 - 59.00	2.502	.000	162.95	4.584	.261	145.01
1715	160.00 - 160.50	59.00 - 59.50	2.502	.000	180.28	4.506	.224	177.24

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*                          *       SEISMIC MAP OF ALASKA        *                                  *
*****************************************************************************************************
*  GRID     LONG1 - LONG2      LAT1 - LAT2       A(H)   C(H)    R(H)        A(N)   C(N)    R(N)    *
*****************************************************************************************************
*                                                                                                  *
*  1716    160.00 - 160.50    59.50 - 60.00     2.803  .000   222.39       4.338   .183   183.23   *
*  1717    160.00 - 160.50    60.00 - 60.50     2.979  .000   230.37       4.122   .210   168.41   *
*  1718    160.00 - 160.50    60.50 - 61.00     2.979  .000   218.00       4.045   .215   158.23   *
*  1719    160.00 - 160.50    61.00 - 61.50     3.104  .000   202.81       4.117   .194   166.89   *
*  1720    160.00 - 160.50    61.50 - 62.00     3.104  .000   178.03       4.049   .195   151.06   *
*  1721    160.00 - 160.50    62.00 - 62.50     3.104  .000   156.41       3.852   .157   106.85   *
*  1722    160.00 - 160.50    62.50 - 63.00     3.104  .000   137.33       3.830   .147    61.11   *
*  1723    160.00 - 160.50    63.00 - 63.50     3.350  .425   134.77       3.778   .126    99.76   *
*  1724    160.00 - 160.50    63.50 - 64.00     3.350  .425   109.50       3.841   .134   116.16   *
*  1725    160.00 - 160.50    64.00 - 64.50     3.350  .425    93.17       3.864   .131    80.26   *
*  1726    160.00 - 160.50    64.50 - 65.00     3.350  .425   103.55       3.864   .131    24.82   *
*  1727    160.00 - 160.50    65.00 - 65.50     3.350  .425   112.62       3.867   .126    78.74   *
*  1728    160.00 - 160.50    65.50 - 66.00     3.350  .425   110.65       3.840   .127   106.61   *
*  1729    160.00 - 160.50    66.00 - 66.50     3.331  .428   108.26       3.815   .134   104.15   *
*  1730    160.00 - 160.50    66.50 - 67.00     3.309  .434   114.24       3.808   .138    83.16   *
*  1731    160.00 - 160.50    67.00 - 67.50     3.309  .434   130.57       3.791   .148    36.96   *
*  1732    160.00 - 160.50    67.50 - 68.00     3.350  .425   154.30       3.808   .138    76.77   *
*  1733    160.00 - 160.50    68.00 - 68.50     3.331  .426   178.26       3.604   .160    29.32   *
*  1734    160.00 - 160.50    68.50 - 69.00     3.282  .447   204.71       3.504   .137    78.70   *
*  1735    160.00 - 160.50    69.00 - 69.50     3.245  .470   233.64       3.451   .132   121.30   *
*  1736    160.00 - 160.50    69.50 - 70.00      .000  .000      .00       3.372   .184   153.79   *
*  1737    160.00 - 160.50    70.00 - 70.50      .000  .000      .00       3.280   .183   182.87   *
*  1738    160.00 - 160.50    70.50 - 71.00      .000  .000      .00       2.780   .175   177.40   *
*  1739    160.00 - 160.50    71.00 - 71.50      .000  .000      .00       2.780   .175   209.93   *
*  1740    160.00 - 160.50    71.50 - 72.00      .000  .000      .00       2.071   .000   192.70   *
*  1741    160.50 - 161.00    54.00 - 54.50     3.103  .001   112.80       5.012   .253    92.37   *
*  1742    160.50 - 161.00    54.50 - 55.00     3.152  .049    92.15       5.070   .252    94.31   *
*  1743    160.50 - 161.00    55.00 - 55.50     3.152  .049    74.65       5.071   .251    62.83   *
*  1744    160.50 - 161.00    55.50 - 56.00     3.152  .049    95.22       5.072   .250   104.54   *
*  1745    160.50 - 161.00    56.00 - 56.50     3.104  .000   130.57       5.048   .246    84.03   *
*  1746    160.50 - 161.00    56.50 - 57.00     2.979  .000   149.21       4.967   .244   133.59   *
*  1747    160.50 - 161.00    57.00 - 57.50     2.979  .000   173.12       4.810   .247   150.07   *
*  1748    160.50 - 161.00    57.50 - 58.00     2.803  .000   171.30       4.614   .277   156.22   *
*  1749    160.50 - 161.00    58.00 - 58.50     2.803  .000   186.61       4.548   .254   169.02   *
*  1750    160.50 - 161.00    58.50 - 59.00     2.502  .000   179.76       4.474   .257   173.37   *
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                              SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)     C(H)     R(H)         A(N)    C(N)     R(N)

  1751    160.50 - 161.00    59.00 - 59.50     2.502     .000    195.61       4.377    .210    186.84
  1752    160.50 - 161.00    59.50 - 60.00     2.803     .000    234.83       4.157    .182    194.12
  1753    160.50 - 161.00    60.00 - 60.50     2.979     .000    240.84       3.822    .308    152.56
  1754    160.50 - 161.00    60.50 - 61.00     2.979     .000    228.88       3.871    .216    161.44
  1755    160.50 - 161.00    61.00 - 61.50     3.104     .000    209.42       3.999    .216    158.92
  1756    160.50 - 161.00    61.50 - 62.00     3.104     .000    184.92       3.958    .192    132.17
  1757    160.50 - 161.00    62.00 - 62.50     3.104     .000    162.58       3.781    .147    110.62
  1758    160.50 - 161.00    62.50 - 63.00     3.104     .000    140.75       3.771    .141     92.20
  1759    160.50 - 161.00    63.00 - 63.50     3.350     .425    132.85       3.734    .126    108.15
  1760    160.50 - 161.00    63.50 - 64.00     3.350     .425     96.72       3.815    .142    117.06
  1761    160.50 - 161.00    64.00 - 64.50     3.350     .425     70.11       3.841    .134     83.40
  1762    160.50 - 161.00    64.50 - 65.00     3.350     .425     93.04       3.841    .134     42.27
  1763    160.50 - 161.00    65.00 - 65.50     3.350     .425    114.23       3.844    .129     81.16
  1764    160.50 - 161.00    65.50 - 66.00     3.350     .425    118.40       3.815    .134    104.96
  1765    160.50 - 161.00    66.00 - 66.50     3.350     .425    118.70       3.815    .134    102.95
  1766    160.50 - 161.00    66.50 - 67.00     3.331     .428    124.93       3.808    .138     84.45
  1767    160.50 - 161.00    67.00 - 67.50     3.331     .428    139.43       3.791    .148     56.65
  1768    160.50 - 161.00    67.50 - 68.00     3.282     .447    158.62       3.811    .149     81.85
  1769    160.50 - 161.00    68.00 - 68.50     3.282     .447    182.59       3.620    .177     46.46
  1770    160.50 - 161.00    68.50 - 69.00     3.282     .447    209.07       3.939    .161     86.20
  1771    160.50 - 161.00    69.00 - 69.50     3.245     .470    238.06       3.451    .132    123.11
  1772    160.50 - 161.00    69.50 - 70.00      .000     .000       .00       3.372    .184    154.42
  1773    160.50 - 161.00    70.00 - 70.50      .000     .000       .00       3.280    .183    183.51
  1774    160.50 - 161.00    70.50 - 71.00      .000     .000       .00       2.780    .175    176.78
  1775    160.50 - 161.00    71.00 - 71.50      .000     .000       .00       2.780    .175    209.17
  1776    160.50 - 161.00    71.50 - 72.00      .000     .000       .00        .000    .000       .00
  1777    161.00 - 161.50    54.00 - 54.50     3.103     .001    101.12       5.045    .253     76.62
  1778    161.00 - 161.50    54.50 - 55.00     3.152     .049     73.33       5.064    .253     65.94
  1779    161.00 - 161.50    55.00 - 55.50     3.152     .049     42.23       5.067    .252     74.78
  1780    161.00 - 161.50    55.50 - 56.00     3.152     .049     75.56       5.064    .251     87.14
  1781    161.00 - 161.50    56.00 - 56.50     3.104     .000    120.59       5.041    .248     88.81
  1782    161.00 - 161.50    56.50 - 57.00     2.979     .000    145.81       4.950    .242    131.14
  1783    161.00 - 161.50    57.00 - 57.50     2.979     .000    174.86       4.783    .244    152.69
  1784    161.00 - 161.50    57.50 - 58.00     2.803     .000    178.88       4.571    .274    161.07
  1785    161.00 - 161.50    58.00 - 58.50     2.803     .000    197.00       4.507    .251    178.35
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                              SEISMIC MAP OF ALASKA

   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    O(H)    R(H)          A(N)    B(N)    R(N)

   1786   161.00 - 161.50    58.50 - 59.00      2.502   .000    196.86        4.424   .257    189.64
   1787   161.00 - 161.50    59.00 - 59.50      2.502   .000    211.43        4.340   .227    201.55
   1788   161.00 - 161.50    59.50 - 60.00      2.803   .000    247.77        4.106   .188    194.63
   1789   161.00 - 161.50    60.00 - 60.50      2.979   .000    251.93        3.872   .239    181.46
   1790   161.00 - 161.50    60.50 - 61.00      2.979   .000    240.36        3.794   .224    164.37
   1791   161.00 - 161.50    61.00 - 61.50      3.104   .000    215.51        3.793   .214    134.16
   1792   161.00 - 161.50    61.50 - 62.00      3.104   .000    190.89        3.744   .165     77.05
   1793   161.00 - 161.50    62.00 - 62.50      3.104   .000    167.47        3.760   .156    113.44
   1794   161.00 - 161.50    62.50 - 63.00      3.104   .000    142.93        3.759   .148    115.46
   1795   161.00 - 161.50    63.00 - 63.50      3.350   .425    130.74        3.724   .139    119.08
   1796   161.00 - 161.50    63.50 - 64.00      3.365   .424     85.27        3.779   .158    118.42
   1797   161.00 - 161.50    64.00 - 64.50      3.365   .424     42.72        3.826   .147     92.86
   1798   161.00 - 161.50    64.50 - 65.00      3.365   .424     82.89        3.826   .147     67.72
   1799   161.00 - 161.50    65.00 - 65.50      3.365   .424    114.38        3.829   .141     88.30
   1800   161.00 - 161.50    65.50 - 66.00      3.365   .424    123.20        3.798   .149    103.18
   1801   161.00 - 161.50    66.00 - 66.50      3.350   .425    126.29        3.805   .144     98.49
   1802   161.00 - 161.50    66.50 - 67.00      3.331   .428    132.85        3.798   .149     80.62
   1803   161.00 - 161.50    67.00 - 67.50      3.331   .428    146.40        3.790   .154     69.99
   1804   161.00 - 161.50    67.50 - 68.00      3.282   .447    165.20        3.811   .149     88.62
   1805   161.00 - 161.50    68.00 - 68.50      3.282   .447    187.91        3.620   .177     70.24
   1806   161.00 - 161.50    68.50 - 69.00      3.282   .447    213.39        3.539   .161     95.31
   1807   161.00 - 161.50    69.00 - 69.50      3.245   .470    242.72        3.451   .132    126.53
   1808   161.00 - 161.50    69.50 - 70.00       .000   .000       .00        3.372   .184    156.01
   1809   161.00 - 161.50    70.00 - 70.50       .000   .000       .00        3.280   .183    184.90
   1810   161.00 - 161.50    70.50 - 71.00       .000   .000       .00        2.780   .175    176.81
   1811   161.00 - 161.50    71.00 - 71.50       .000   .000       .00        2.780   .175    208.98
   1812   161.00 - 161.50    71.50 - 72.00       .000   .000       .00         .000   .000       .00
   1813   161.50 - 162.00    54.00 - 54.50      3.103   .001     92.80        5.035   .252     70.99
   1814   161.50 - 162.00    54.50 - 55.00      3.103   .001     61.63        5.089   .248     54.71
   1815   161.50 - 162.00    55.00 - 55.50      3.103   .001     18.47        5.091   .248     98.45
   1816   161.50 - 162.00    55.50 - 56.00      3.103   .001     63.92        5.090   .247    112.59
   1817   161.50 - 162.00    56.00 - 56.50      2.979   .000    105.08        5.047   .242     63.28
   1818   161.50 - 162.00    56.50 - 57.00      2.803   .003    129.12        4.948   .242    122.88
   1819   161.50 - 162.00    57.00 - 57.50      2.803   .000    166.60        4.774   .246    154.35
   1820   161.50 - 162.00    57.50 - 58.00      2.502   .000    172.79        4.543   .266    166.53
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*                     *   SEISMIC MAP OF ALASKA   *                                          *
*   GRID   LONG1 - LONG2    LAT1 - LAT2       A(H)    C(H)    R(H)       A(N)   C(N)    R(N)  *
*
*   1821   161.50 - 162.00   58.00 - 58.50    2.803   .000   206.44     4.457   .248   185.65  *
*   1822   161.50 - 162.00   58.50 - 59.00    2.502   .000   214.17     4.362   .257   199.49  *
*   1823   161.50 - 162.00   59.00 - 59.50    2.502   .000   227.64     4.310   .242   216.02  *
*   1824   161.50 - 162.00   59.50 - 60.00    2.502   .000   245.26     4.078   .203   209.78  *
*   1825   161.50 - 162.00   60.00 - 60.50    2.803   .000   267.37     3.781   .248   187.79  *
*   1826   161.50 - 162.00   60.50 - 61.00    2.803   .000   263.04     3.728   .233   169.22  *
*   1827   161.50 - 162.00   61.00 - 61.50    3.104   .000   221.11     3.698   .224   121.68  *
*   1828   161.50 - 162.00   61.50 - 62.00    3.104   .000   196.08     3.723   .185    42.44  *
*   1829   161.50 - 162.00   62.00 - 62.50    3.104   .000   171.48     3.752   .160   115.58  *
*   1830   161.50 - 162.00   62.50 - 63.00    3.201   .000   155.68     3.756   .154   131.49  *
*   1831   161.50 - 162.00   63.00 - 63.50    3.365   .424   130.31     3.723   .146   128.51  *
*   1832   161.50 - 162.00   63.50 - 64.00    3.365   .424    80.03     3.798   .157   124.81  *
*   1833   161.50 - 162.00   64.00 - 64.50    3.365   .424    24.11     3.841   .150   103.99  *
*   1834   161.50 - 162.00   64.50 - 65.00    3.365   .424    78.18     3.841   .150    86.93  *
*   1835   161.50 - 162.00   65.00 - 65.50    3.365   .424   115.04     3.844   .145    94.68  *
*   1836   161.50 - 162.00   65.50 - 66.00    3.365   .424   126.71     3.815   .150   102.53  *
*   1837   161.50 - 162.00   66.00 - 66.50    3.350   .425   131.37     3.794   .155    91.49  *
*   1838   161.50 - 162.00   66.50 - 67.00    3.331   .428   138.42     3.794   .155    68.04  *
*   1839   161.50 - 162.00   67.00 - 67.50    3.331   .428   151.71     3.787   .161    59.85  *
*   1840   161.50 - 162.00   67.50 - 68.00    3.282   .447   170.77     3.790   .154    91.98  *
*   1841   161.50 - 162.00   68.00 - 68.50    3.282   .447   192.71     3.588   .162    85.39  *
*   1842   161.50 - 162.00   68.50 - 69.00    3.282   .447   217.52     3.498   .145   101.74  *
*   1843   161.50 - 162.00   69.00 - 69.50    3.245   .470   247.54     3.451   .132   130.93  *
*   1844   161.50 - 162.00   69.50 - 70.00     .000   .000      .00     3.372   .184   158.34  *
*   1845   161.50 - 162.00   70.00 - 70.50     .000   .000      .00     3.280   .183   186.93  *
*   1846   161.50 - 162.00   70.50 - 71.00     .000   .000      .00     2.780   .175   177.41  *
*   1847   161.50 - 162.00   71.00 - 71.50     .000   .000      .00     2.780   .175   209.33  *
*   1848   161.50 - 162.00   71.50 - 72.00     .000   .000      .00      .000   .000      .00  *
*   1849   162.00 - 162.50   54.00 - 54.50    3.103   .001    86.27     5.035   .247    54.50  *
*   1850   162.00 - 162.50   54.50 - 55.00    3.103   .001    66.58     5.096   .240    67.22  *
*   1851   162.00 - 162.50   55.00 - 55.50    3.103   .001    39.90     5.097   .240   103.35  *
*   1852   162.00 - 162.50   55.50 - 56.00    3.103   .001    71.35     5.095   .240   123.42  *
*   1853   162.00 - 162.50   56.00 - 56.50    2.979   .000   107.30     5.039   .236    88.11  *
*   1854   162.00 - 162.50   56.50 - 57.00    2.803   .000   129.71     4.931   .237    94.48  *
*   1855   162.00 - 162.50   57.00 - 57.50    2.803   .000   166.36     4.743   .241   155.06  *
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                               SEISMIC MAP OF ALASKA

 GRID    LONG1 - LONG2    LAT1 - LAT2      A(H)    C(H)    R(H)        A(N)   C(N)    R(N)

 1856   162.00 - 162.50   57.50 - 58.00    2.502   .000   173.91       4.488   .260   170.62
 1857   162.00 - 162.50   58.00 - 58.50    2.502   .000   208.17       4.417   .239   193.13
 1858   162.00 - 162.50   58.50 - 59.00     .000   .000      .00       4.322   .255   209.82
 1859   162.00 - 162.50   59.00 - 59.50     .000   .000      .00       4.258   .243   226.56
 1860   162.00 - 162.50   59.50 - 60.00     .000   .000      .00       4.034   .228   224.20
 1861   162.00 - 162.50   60.00 - 60.50     .000   .000      .00       3.654   .275   189.76
 1862   162.00 - 162.50   60.50 - 61.00     .000   .000      .00       3.605   .248   167.78
 1863   162.00 - 162.50   61.00 - 61.50    2.979   .000   225.04       3.632   .228   126.28
 1864   162.00 - 162.50   61.50 - 62.00    2.979   .000   196.10       3.681   .200    74.48
 1865   162.00 - 162.50   62.00 - 62.50    2.979   .000   167.13       3.704   .175   122.33
 1866   162.00 - 162.50   62.50 - 63.00    3.104   .000   150.21       3.731   .169   141.20
 1867   162.00 - 162.50   63.00 - 63.50    3.350   .425   133.19       3.728   .155   136.78
 1868   162.00 - 162.50   63.50 - 64.00    3.365   .424    85.34       3.795   .164   128.50
 1869   162.00 - 162.50   64.00 - 64.50    3.365   .424    42.72       3.823   .153   107.64
 1870   162.00 - 162.50   64.50 - 65.00    3.365   .424    83.11       3.823   .153    91.07
 1871   162.00 - 162.50   65.00 - 65.50    3.365   .424   116.62       3.826   .147    90.94
 1872   162.00 - 162.50   65.50 - 66.00    3.365   .424   128.46       3.794   .155    97.03
 1873   162.00 - 162.50   66.00 - 66.50    3.350   .425   133.65       3.794   .155    84.81
 1874   162.00 - 162.50   66.50 - 67.00    3.331   .428   141.26       3.794   .155    45.98
 1875   162.00 - 162.50   67.00 - 67.50    3.331   .428   155.04       3.787   .161    41.90
 1876   162.00 - 162.50   67.50 - 68.00    3.282   .447   175.01       3.787   .161    95.58
 1877   162.00 - 162.50   68.00 - 68.50    3.282   .447   196.81       3.584   .167    96.57
 1878   162.00 - 162.50   68.50 - 69.00    3.282   .447   221.35       3.491   .154   109.84
 1879   162.00 - 162.50   69.00 - 69.50    3.245   .470   252.43       3.443   .144   134.88
 1880   162.00 - 162.50   69.50 - 70.00     .000   .000      .00       3.372   .184   161.19
 1881   162.00 - 162.50   70.00 - 70.50     .000   .000      .00       3.280   .183   189.54
 1882   162.00 - 162.50   70.50 - 71.00     .000   .000      .00       2.780   .175   178.54
 1883   162.00 - 162.50   71.00 - 71.50     .000   .000      .00       2.780   .175   210.19
 1884   162.00 - 162.50   71.50 - 72.00     .000   .000      .00        .000   .000      .00
 1885   162.50 - 163.00   54.00 - 54.50    3.103   .001    77.68       5.051   .241    49.04
 1886   162.50 - 163.00   54.50 - 55.00    3.103   .001    74.54       5.064   .245    49.44
 1887   162.50 - 163.00   55.00 - 55.50    3.103   .001    67.46       5.063   .245    98.20
 1888   162.50 - 163.00   55.50 - 56.00    3.103   .001    87.57       5.060   .245   124.79
 1889   162.50 - 163.00   56.00 - 56.50    2.979   .000   114.60       5.008   .229   125.45
 1890   162.50 - 163.00   56.50 - 57.00    2.803   .000   133.49       4.889   .251   131.85
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                              SEISMIC MAP OF ALASKA

   GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)   C(H)    R(H)        A(N)   C(N)    R(N)

   1891   162.50 - 163.00    57.00 - 57.50     2.803   .000  168.51       4.644   .269  152.23
   1892   162.50 - 163.00    57.50 - 58.00     2.502   .000  177.21       4.424   .251  177.34
   1893   162.50 - 163.00    58.00 - 58.50     2.502   .000  210.94       4.327   .238  197.28
   1894   162.50 - 163.00    58.50 - 59.00      .000   .000     .00       4.254   .280  219.39
   1895   162.50 - 163.00    59.00 - 59.50      .000   .000     .00       4.168   .278  236.72
   1896   162.50 - 163.00    59.50 - 60.00      .000   .000     .00       3.904   .258  232.38
   1897   162.50 - 163.00    60.00 - 60.50      .000   .000     .00       3.473   .247  187.42
   1898   162.50 - 163.00    60.50 - 61.00      .000   .000     .00       3.387   .198  158.47
   1899   162.50 - 163.00    61.00 - 61.50     2.803   .000  219.88       3.564   .269  140.82
   1900   162.50 - 163.00    61.50 - 62.00     2.803   .000  187.22       3.645   .233  115.98
   1901   162.50 - 163.00    62.00 - 62.50     2.803   .000  154.98       3.675   .200  137.73
   1902   162.50 - 163.00    62.50 - 63.00     2.979   .000  141.29       3.698   .200  149.31
   1903   162.50 - 163.00    63.00 - 63.50     3.309   .434  136.75       3.706   .175  141.46
   1904   162.50 - 163.00    63.50 - 64.00     3.350   .425   96.94       3.779   .175  129.46
   1905   162.50 - 163.00    64.00 - 64.50     3.350   .425   69.95       3.814   .158  106.45
   1906   162.50 - 163.00    64.50 - 65.00     3.350   .425   93.22       3.814   .158   83.07
   1907   162.50 - 163.00    65.00 - 65.50     3.350   .425  117.89       3.819   .152   78.56
   1908   162.50 - 163.00    65.50 - 66.00     3.350   .425  127.40       3.787   .161   90.34
   1909   162.50 - 163.00    66.00 - 66.50     3.350   .425  132.75       3.772   .163   80.07
   1910   162.50 - 163.00    66.50 - 67.00     3.331   .428  141.00       3.772   .163   28.07
   1911   162.50 - 163.00    67.00 - 67.50     3.331   .428  156.16       3.763   .169   58.21
   1912   162.50 - 163.00    67.50 - 68.00     3.282   .447  177.71       3.787   .161  101.20
   1913   162.50 - 163.00    68.00 - 68.50     3.282   .447  200.09       3.584   .167  103.52
   1914   162.50 - 163.00    68.50 - 69.00     3.282   .447  224.80       3.491   .154  115.99
   1915   162.50 - 163.00    69.00 - 69.50     3.245   .470  257.34       3.435   .157  138.47
   1916   162.50 - 163.00    69.50 - 70.00      .000   .000     .00       3.372   .184  164.35
   1917   162.50 - 163.00    70.00 - 70.50      .000   .000     .00       3.280   .183  192.62
   1918   162.50 - 163.00    70.50 - 71.00      .000   .000     .00       2.780   .175  180.13
   1919   162.50 - 163.00    71.00 - 71.50      .000   .000     .00       2.780   .175  211.53
   1920   162.50 - 163.00    71.50 - 72.00      .000   .000     .00        .000   .000     .00
   1921   163.00 - 163.50    54.00 - 54.50     3.103   .001   62.82       5.028   .242   34.95
   1922   163.00 - 163.50    54.50 - 55.00     3.103   .001   73.68       5.083   .246   56.10
   1923   163.00 - 163.50    55.00 - 55.50     3.103   .001   84.91       5.081   .246   99.49
   1924   163.00 - 163.50    55.50 - 56.00     3.103   .001  103.21       5.076   .245  130.14
   1925   163.00 - 163.50    56.00 - 56.50     2.979   .000  124.24       5.004   .224  143.96
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                               SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)    B(H)    R(H)        A(N)    B(N)    R(N)

  1526   163.00 - 163.50    56.50 - 57.00     2.803   .000   139.60       4.877   .246   153.41
  1527   163.00 - 163.50    57.00 - 57.50     2.803   .000   172.67       4.623   .266   161.79
  1528   163.00 - 163.50    57.50 - 58.00     2.502   .000   182.58       4.372   .258   182.07
  1529   163.00 - 163.50    58.00 - 58.50     2.502   .000   215.48       4.161   .220   191.82
  1530   163.00 - 163.50    58.50 - 59.00      .000   .000      .00       4.052   .258   212.51
  1531   163.00 - 163.50    59.00 - 59.50      .000   .000      .00       3.871   .228   217.77
  1532   163.00 - 163.50    59.50 - 60.00      .000   .000      .00       3.564   .226   218.51
  1533   163.00 - 163.50    60.00 - 60.50      .000   .000      .00       3.152   .175   172.89
  1534   163.00 - 163.50    60.50 - 61.00      .000   .000      .00       3.013   .154   132.61
  1535   163.00 - 163.50    61.00 - 61.50     2.803   .000   218.63       3.354   .211   141.91
  1536   163.00 - 163.50    61.50 - 62.00     2.803   .000   186.09       3.587   .245   145.77
  1537   163.00 - 163.50    62.00 - 62.50     2.803   .000   154.25       3.622   .208   152.01
  1538   163.00 - 163.50    62.50 - 63.00     2.979   .000   141.27       3.650   .202   155.02
  1539   163.00 - 163.50    63.00 - 63.50     3.104   .000   120.88       3.657   .180   141.67
  1540   163.00 - 163.50    63.50 - 64.00     3.309   .434   107.37       3.758   .198   128.70
  1541   163.00 - 163.50    64.00 - 64.50     3.309   .434    89.70       3.798   .175   100.28
  1542   163.00 - 163.50    64.50 - 65.00     3.309   .434   101.63       3.798   .175    62.20
  1543   163.00 - 163.50    65.00 - 65.50     3.309   .434   117.62       3.801   .168    56.31
  1544   163.00 - 163.50    65.50 - 66.00     3.309   .434   123.60       3.783   .168    82.34
  1545   163.00 - 163.50    66.00 - 66.50     3.350   .425   128.18       3.763   .169    82.05
  1546   163.00 - 163.50    66.50 - 67.00     3.331   .428   137.34       3.763   .169    45.37
  1547   163.00 - 163.50    67.00 - 67.50     3.331   .428   155.00       3.755   .176    75.61
  1548   163.00 - 163.50    67.50 - 68.00     3.282   .447   178.83       3.763   .169   106.38
  1549   163.00 - 163.50    68.00 - 68.50     3.282   .447   202.53       3.547   .153   102.89
  1550   163.00 - 163.50    68.50 - 69.00     3.282   .447   227.85       3.443   .144   114.47
  1551   163.00 - 163.50    69.00 - 69.50     3.245   .470   262.23       3.435   .157   141.99
  1552   163.00 - 163.50    69.50 - 70.00      .000   .000      .00       3.372   .184   167.66
  1553   163.00 - 163.50    70.00 - 70.50      .000   .000      .00       3.280   .183   196.12
  1554   163.00 - 163.50    70.50 - 71.00      .000   .000      .00       2.822   .122   185.14
  1555   163.50 - 164.00    54.00 - 54.50     3.103   .001    39.15       5.055   .248    39.80
  1556   163.50 - 164.00    54.50 - 55.00     3.103   .001    65.13       5.071   .247    56.22
  1557   163.50 - 164.00    55.00 - 55.50     3.103   .001    92.45       5.069   .247    99.34
  1558   163.50 - 164.00    55.50 - 56.00     3.103   .001   114.78       5.060   .245   130.13
  1559   163.50 - 164.00    56.00 - 56.50     2.979   .000   134.12       4.977   .218   148.22
  1560   163.50 - 164.00    56.50 - 57.00     2.803   .000   147.19       4.800   .305   153.36
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*****************************************************************************************************
*                              *      SEISMIC MAP OF ALASKA      *                                  *
*****************************************************************************************************
*   GFID    LONG1 - LONG2     LAT1 - LAT2        A(H)    Q(H)     R(H)          A(N)    Q(N)    R(N)  *
*****************************************************************************************************
*                                                                                                   *
*   1561   163.50 - 164.00   57.00 - 57.50      2.803   .000   178.44         4.627   .249   175.75  *
*   1562   163.50 - 164.00   57.50 - 58.00      2.502   .000   189.85         4.297   .260   183.63  *
*   1563   163.50 - 164.00   58.00 - 58.50      2.502   .000   221.47         4.110   .210   197.12  *
*   1564   163.50 - 164.00   58.50 - 59.00       .000   .000      .00         3.785   .249   216.30  *
*   1565   163.50 - 164.00   59.00 - 59.50       .000   .000      .00         3.767   .199   217.10  *
*   1566   163.50 - 164.00   59.50 - 60.00       .000   .000      .00         3.407   .179   208.16  *
*   1567   163.50 - 164.00   60.00 - 60.50       .000   .000      .00         3.013   .154   164.25  *
*   1568   163.50 - 164.00   60.50 - 61.00       .000   .000      .00         3.013   .154   145.48  *
*   1569   163.50 - 164.00   61.00 - 61.50      2.803   .000   218.01         2.954   .145   118.81  *
*   1570   163.50 - 164.00   61.50 - 62.00      2.803   .000   185.55         3.476   .310   160.12  *
*   1571   163.50 - 164.00   62.00 - 62.50      2.803   .000   153.95         3.567   .242   162.39  *
*   1572   163.50 - 164.00   62.50 - 63.00      2.979   .000   141.24         3.602   .231   158.19  *
*   1573   163.50 - 164.00   63.00 - 63.50      3.104   .000   122.75         3.602   .231   140.43  *
*   1574   163.50 - 164.00   63.50 - 64.00      3.104   .000    97.15         3.714   .205   124.33  *
*   1575   163.50 - 164.00   64.00 - 64.50      3.104   .000    85.50         3.759   .177    92.54  *
*   1576   163.50 - 164.00   64.50 - 65.00      3.104   .000    91.51         3.759   .177    39.63  *
*   1577   163.50 - 164.00   65.00 - 65.50      3.104   .000   101.47         3.783   .168    34.64  *
*   1578   163.50 - 164.00   65.50 - 66.00      3.104   .000   103.27         3.783   .168    75.35  *
*   1579   163.50 - 164.00   66.00 - 66.50      3.309   .434   117.52         3.759   .177    87.91  *
*   1580   163.50 - 164.00   66.50 - 67.00      3.309   .434   130.19         3.759   .177    70.89  *
*   1581   163.50 - 164.00   67.00 - 67.50      3.309   .434   152.79         3.751   .184    90.12  *
*   1582   163.50 - 164.00   67.50 - 68.00      3.282   .447   178.50         3.755   .176   111.60  *
*   1583   163.50 - 164.00   68.00 - 68.50      3.282   .447   204.19         3.534   .151    97.26  *
*   1584   163.50 - 164.00   68.50 - 69.00      3.282   .447   230.53         3.443   .144   113.07  *
*   1585   163.50 - 164.00   69.00 - 69.50      3.245   .470   267.11         3.394   .126   139.72  *
*   1586   163.50 - 164.00   69.50 - 70.00       .000   .000      .00         3.326   .150   164.96  *
*   1587   163.50 - 164.00   70.00 - 70.50       .000   .000      .00         3.199   .123   187.02  *
*   1588   163.50 - 164.00   70.50 - 71.00       .000   .000      .00         2.822   .122   187.10  *
*   1589   164.00 - 164.50   53.00 - 53.50      3.103   .001    34.28         5.068   .247    56.29  *
*   1590   164.00 - 164.50   53.50 - 54.00      3.103   .001    47.03         5.070   .248    42.17  *
*   1591   164.00 - 164.50   54.00 - 54.50      3.103   .001    18.33         5.070   .248    29.93  *
*   1592   164.00 - 164.50   54.50 - 55.00      3.103   .001    59.77         5.100   .256    64.56  *
*   1593   164.00 - 164.50   55.00 - 55.50      3.103   .001    96.53         5.098   .257   104.04  *
*   1594   164.00 - 164.50   55.50 - 56.00      3.103   .001   123.35         5.067   .243   130.73  *
*   1595   164.00 - 164.50   56.00 - 56.50      2.979   .000   143.53         4.977   .220   150.99  *
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                                  SEISMIC MAP OF ALASKA
  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)          A(N)    C(N)     R(N)

  1996   164.00 - 164.50   56.50 - 57.00      2.803    .000    155.70         4.806    .308    158.94
  1997   164.00 - 164.50   57.00 - 57.50      2.803    .000    185.48         4.623    .253    183.27
  1998   164.00 - 164.50   57.50 - 58.00      2.502    .000    198.81         4.283    .274    191.94
  1999   164.00 - 164.50   58.00 - 58.50      2.502    .000    229.38         3.984    .208    188.25
  2000   164.00 - 164.50   58.50 - 59.00       .000    .000       .00         3.840    .215    204.06
  2001   164.00 - 164.50   59.00 - 59.50       .000    .000       .00         3.739    .225    223.44
  2002   164.00 - 164.50   59.50 - 60.00       .000    .000       .00         3.431    .204    220.27
  2003   164.00 - 164.50   60.00 - 60.50       .000    .000       .00         3.013    .154    176.07
  2004   164.00 - 164.50   60.50 - 61.00       .000    .000       .00         3.013    .154    159.33
  2005   164.00 - 164.50   61.00 - 61.50      2.803    .000    218.01         2.954    .145    136.30
  2006   164.00 - 164.50   61.50 - 62.00      2.803    .000    185.55         3.476    .310    180.48
  2007   164.00 - 164.50   62.00 - 62.50      2.803    .000    153.95         3.567    .242    174.82
  2008   164.00 - 164.50   62.50 - 63.00      2.979    .000    140.81         3.602    .231    164.40
  2009   164.00 - 164.50   63.00 - 63.50      3.104    .000    122.23         3.602    .231    142.84
  2010   164.00 - 164.50   63.50 - 64.00      3.104    .000     96.68         3.667    .248    119.96
  2011   164.00 - 164.50   64.00 - 64.50      3.104    .000     84.87         3.705    .230     86.75
  2012   164.00 - 164.50   64.50 - 65.00      3.104    .000     89.82         3.705    .230     50.73
  2013   164.00 - 164.50   65.00 - 65.50      3.104    .000     96.46         3.733    .216     26.66
  2014   164.00 - 164.50   65.50 - 66.00      3.104    .000     92.46         3.733    .216     68.76
  2015   164.00 - 164.50   66.00 - 66.50      3.104    .000     88.58         3.759    .177     94.46
  2016   164.00 - 164.50   66.50 - 67.00      3.104    .000    103.86         3.759    .177     91.53
  2017   164.00 - 164.50   67.00 - 67.50      3.104    .000    133.70         3.751    .184    103.89
  2018   164.00 - 164.50   67.50 - 68.00      3.245    .470    176.91         3.755    .176    114.31
  2019   164.00 - 164.50   68.00 - 68.50      3.245    .470    206.71         3.534    .151     81.75
  2020   164.00 - 164.50   68.50 - 69.00      3.245    .470    236.02         3.443    .144    107.58
  2021   164.00 - 164.50   69.00 - 69.50      3.245    .470    272.00         3.394    .126    141.47
  2022   164.00 - 164.50   69.50 - 70.00       .000    .000       .00         3.326    .150    168.11
  2023   164.00 - 164.50   70.00 - 70.50       .000    .000       .00         3.199    .123    190.51
  2024   164.00 - 164.50   70.50 - 71.00       .000    .000       .00         2.822    .122    189.38
  2025   164.50 - 165.00   53.00 - 53.50      3.103    .001     18.08         5.093    .253     56.65
  2026   164.50 - 165.00   53.50 - 54.00      3.103    .001     47.91         5.094    .253     34.42
  2027   164.50 - 165.00   54.00 - 54.50      3.103    .001     39.17         5.094    .253     37.46
  2028   164.50 - 165.00   54.50 - 55.00      3.103    .001     67.22         5.140    .272     71.36
  2029   164.50 - 165.00   55.00 - 55.50      3.103    .001    102.58         5.137    .272    110.43
  2030   164.50 - 165.00   55.50 - 56.00      3.103    .001    131.22         5.084    .248    124.20
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
2031	164.50 - 165.00	56.00 - 56.50	2.979	.000	152.75	4.988	.224	152.05
2032	164.50 - 165.00	56.50 - 57.00	2.803	.000	164.93	4.796	.306	162.22
2033	164.50 - 165.00	57.00 - 57.50	2.803	.000	193.58	4.620	.250	188.63
2034	164.50 - 165.00	57.50 - 58.00	2.502	.000	209.23	4.276	.269	198.22
2035	164.50 - 165.00	58.00 - 58.50	2.803	.000	235.48	3.964	.221	195.26
2036	164.50 - 165.00	58.50 - 59.00	2.502	.000	249.88	3.806	.246	210.53
2037	164.50 - 165.00	59.00 - 59.50	2.502	.000	270.47	3.705	.258	232.94
2038	164.50 - 165.00	59.50 - 60.00	2.502	.000	293.67	3.358	.249	231.32
2039	164.50 - 165.00	60.00 - 60.50	.000	.000	.00	2.881	.147	185.80
2040	164.50 - 165.00	60.50 - 61.00	.000	.000	.00	2.881	.147	166.74
2041	164.50 - 165.00	61.00 - 61.50	2.803	.000	218.63	2.954	.145	153.37
2042	164.50 - 165.00	61.50 - 62.00	2.803	.000	186.09	3.476	.310	197.25
2043	164.50 - 165.00	62.00 - 62.50	2.803	.000	154.25	3.567	.242	185.19
2044	164.50 - 165.00	62.50 - 63.00	2.979	.000	140.03	3.602	.231	170.03
2045	164.50 - 165.00	63.00 - 63.50	3.104	.000	119.44	3.602	.231	145.32
2046	164.50 - 165.00	63.50 - 64.00	3.104	.000	89.42	3.667	.248	119.83
2047	164.50 - 165.00	64.00 - 64.50	3.104	.000	73.85	3.705	.230	84.60
2048	164.50 - 165.00	64.50 - 65.00	3.104	.000	82.78	3.705	.230	54.03
2049	164.50 - 165.00	65.00 - 65.50	3.104	.000	90.05	3.733	.216	27.09
2050	164.50 - 165.00	65.50 - 66.00	3.104	.000	80.63	3.733	.216	70.25
2051	164.50 - 165.00	66.00 - 66.50	3.104	.000	70.94	3.711	.220	97.03
2052	164.50 - 165.00	66.50 - 67.00	3.104	.000	89.55	3.711	.220	103.19
2053	164.50 - 165.00	67.00 - 67.50	3.104	.000	124.29	3.711	.220	112.98
2054	164.50 - 165.00	67.50 - 68.00	2.803	.000	129.90	3.755	.176	114.38
2055	164.50 - 165.00	68.00 - 68.50	2.803	.000	163.06	3.534	.151	54.73
2056	164.50 - 165.00	68.50 - 69.00	2.803	.000	196.59	3.443	.144	101.23
2057	164.50 - 165.00	69.00 - 69.50	3.188	.521	278.82	3.518	.185	158.52
2058	164.50 - 165.00	69.50 - 70.00	.000	.000	.00	3.458	.226	188.97
2059	164.50 - 165.00	70.00 - 70.50	.000	.000	.00	3.326	.150	209.22
2060	164.50 - 165.00	70.50 - 71.00	.000	.000	.00	2.822	.122	191.98
2061	165.00 - 165.50	53.00 - 53.50	3.103	.001	38.90	5.131	.267	67.72
2062	165.00 - 165.50	53.50 - 54.00	3.103	.001	57.51	5.132	.267	36.65
2063	165.00 - 165.50	54.00 - 54.50	3.103	.001	63.92	5.132	.267	52.67
2064	165.00 - 165.50	54.50 - 55.00	3.152	.049	86.13	5.146	.273	84.61
2065	165.00 - 165.50	55.00 - 55.50	3.152	.049	114.94	5.142	.272	114.72

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*                           *   SEISMIC MAP OF ALASKA    *                              *
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*  GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)   D(H)    R(H)        A(N)   D(N)    R(N)   *
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*                                                                                       *
*  2066   165.00 - 165.50   55.50 - 56.00    3.152   .049   140.44      5.083   .244    90.25  *
*  2067   165.00 - 165.50   56.00 - 56.50    3.104   .000   168.46      4.969   .221   151.76  *
*  2068   165.00 - 165.50   56.50 - 57.00    2.979   .000   179.32      4.786   .299   163.19  *
*  2069   165.00 - 165.50   57.00 - 57.50    2.979   .000   199.06      4.606   .254   192.02  *
*  2070   165.00 - 165.50   57.50 - 58.00    2.803   .000   210.54      4.234   .284   201.80  *
*  2071   165.00 - 165.50   58.00 - 58.50    2.803   .000   230.43      3.958   .225   200.89  *
*  2072   165.00 - 165.50   58.50 - 59.00    2.502   .000   234.36      3.797   .256   216.04  *
*  2073   165.00 - 165.50   59.00 - 59.50    2.502   .000   256.20      3.692   .271   238.96  *
*  2074   165.00 - 165.50   59.50 - 60.00    2.502   .000   280.59      3.358   .249   237.86  *
*  2075   165.00 - 165.50   60.00 - 60.50     .000   .000      .00      2.881   .147   198.54  *
*  2076   165.00 - 165.50   60.50 - 61.00     .000   .000      .00      2.881   .147   181.34  *
*  2077   165.00 - 165.50   61.00 - 61.50    2.803   .000   219.88      2.881   .147   167.08  *
*  2078   165.00 - 165.50   61.50 - 62.00    2.803   .000   187.22      3.451   .334   211.49  *
*  2079   165.00 - 165.50   62.00 - 62.50    2.803   .000   154.98      3.551   .257   193.89  *
*  2080   165.00 - 165.50   62.50 - 63.00    2.979   .000   139.26      3.587   .245   174.36  *
*  2081   165.00 - 165.50   63.00 - 63.50    3.104   .000   115.59      3.587   .245   146.82  *
*  2082   165.00 - 165.50   63.50 - 64.00    3.104   .000    78.19      3.667   .248   120.64  *
*  2083   165.00 - 165.50   64.00 - 64.50    3.104   .000    55.15      3.705   .230    80.69  *
*  2084   165.00 - 165.50   64.50 - 65.00    3.104   .000    72.81      3.711   .220    42.24  *
*  2085   165.00 - 165.50   65.00 - 65.50    3.104   .000    83.26      3.738   .207    44.09  *
*  2086   165.00 - 165.50   65.50 - 66.00    3.104   .000    68.82      3.738   .207    77.10  *
*  2087   165.00 - 165.50   66.00 - 66.50    3.104   .000    51.34      3.711   .220   102.80  *
*  2088   165.00 - 165.50   66.50 - 67.00    3.104   .000    76.11      3.711   .220   114.40  *
*  2089   165.00 - 165.50   67.00 - 67.50    3.104   .000   116.45      3.711   .220   123.10  *
*  2090   165.00 - 165.50   67.50 - 68.00    2.803   .000   124.66      3.758   .239   116.39  *
*  2091   165.00 - 165.50   68.00 - 68.50    2.803   .000   158.86      3.579   .200    36.70  *
*  2092   165.00 - 165.50   68.50 - 69.00    2.803   .000   193.06      3.472   .257   132.17  *
*  2093   165.00 - 165.50   69.00 - 69.50    2.502   .000   209.10      3.518   .185   161.16  *
*  2094   165.00 - 165.50   69.50 - 70.00     .000   .000      .00      3.458   .226   192.36  *
*  2095   165.50 - 166.00   53.00 - 53.50    3.103   .001    64.47      5.141   .269    66.72  *
*  2096   165.50 - 166.00   53.50 - 54.00    3.152   .049    76.82      5.142   .270    34.34  *
*  2097   165.50 - 166.00   54.00 - 54.50    3.152   .049    87.16      5.141   .270    53.68  *
*  2098   165.50 - 166.00   54.50 - 55.00    3.152   .049   103.08      5.161   .278    97.24  *
*  2099   165.50 - 166.00   55.00 - 55.50    3.152   .049   125.77      5.154   .277   120.85  *
*  2100   165.50 - 166.00   55.50 - 56.00    3.152   .049   147.72      5.087   .245   128.13  *
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*                        *       SEISMIC MAP OF ALASKA        *                             *
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*   GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)    O(H)    R(H)       A(N)   C(N)    R(N)   *
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*                                                                                           *
*   2101   165.50 - 166.00   56.00 - 56.50    3.104   .000   173.10      4.982   .219   156.08  *
*   2102   165.50 - 166.00   56.50 - 57.00    2.979   .000   180.18      4.776   .295   164.82  *
*   2103   165.50 - 166.00   57.00 - 57.50    2.979   .000   196.78      4.588   .252   193.72  *
*   2104   165.50 - 166.00   57.50 - 58.00    2.803   .000   204.07      4.202   .286   202.59  *
*   2105   165.50 - 166.00   58.00 - 58.50    2.803   .000   223.42      3.895   .229   201.70  *
*   2106   165.50 - 166.00   58.50 - 59.00    2.502   .000   219.38      3.731   .262   218.02  *
*   2107   165.50 - 166.00   59.00 - 59.50    2.502   .000   242.57      3.600   .290   241.08  *
*   2108   165.50 - 166.00   59.50 - 60.00    2.502   .000   268.20      3.081   .318   227.55  *
*   2109   165.50 - 166.00   60.00 - 60.50     .000   .000      .00      2.296   .225   166.97  *
*   2110   165.50 - 166.00   60.50 - 61.00     .000   .000      .00      2.296   .225   148.08  *
*   2111   165.50 - 166.00   61.00 - 61.50    2.803   .000   221.79      2.881   .147   193.65  *
*   2112   165.50 - 166.00   61.50 - 62.00    2.803   .000   189.02      3.451   .334   224.14  *
*   2113   165.50 - 166.00   62.00 - 62.50    2.803   .000   156.34      3.551   .257   202.03  *
*   2114   165.50 - 166.00   62.50 - 63.00    2.979   .000   139.13      3.587   .245   179.77  *
*   2115   165.50 - 166.00   63.00 - 63.50    3.104   .000   112.51      3.587   .245   150.59  *
*   2116   165.50 - 166.00   63.50 - 64.00    3.104   .000    67.67      3.653   .262   121.73  *
*   2117   165.50 - 166.00   64.00 - 64.50    3.104   .000    32.86      3.705   .230    79.53  *
*   2118   165.50 - 166.00   64.50 - 65.00    3.104   .000    63.50      3.711   .220    26.23  *
*   2119   165.50 - 166.00   65.00 - 65.50    3.104   .000    76.89      3.738   .207    61.08  *
*   2120   165.50 - 166.00   65.50 - 66.00    3.104   .000    58.72      3.738   .207    86.22  *
*   2121   165.50 - 166.00   66.00 - 66.50    3.104   .000    30.94      3.758   .239   112.27  *
*   2122   165.50 - 166.00   66.50 - 67.00    3.104   .000    65.73      3.758   .239   126.89  *
*   2123   165.50 - 166.00   67.00 - 67.50    3.104   .000   110.94      3.758   .239   135.58  *
*   2124   165.50 - 166.00   67.50 - 68.00    2.803   .000   121.01      3.758   .239   123.23  *
*   2125   165.50 - 166.00   68.00 - 68.50    2.803   .000   155.88      3.579   .200    57.96  *
*   2126   165.50 - 166.00   68.50 - 69.00    2.803   .000   190.53      3.472   .257   107.73  *
*   2127   165.50 - 166.00   69.00 - 69.50    2.502   .000   207.71      3.421   .261   154.88  *
*   2128   165.50 - 166.00   69.50 - 70.00     .000   .000      .00      3.421   .261   192.62  *
*   2129   166.00 - 166.50   53.00 - 53.50    3.103   .001    86.86      5.167   .282    54.60  *
*   2130   166.00 - 166.50   53.50 - 54.00    3.152   .049    95.46      5.168   .282    54.93  *
*   2131   166.00 - 166.50   54.00 - 54.50    3.152   .049   105.15      5.166   .282    71.39  *
*   2132   166.00 - 166.50   54.50 - 55.00    3.152   .049   119.04      5.177   .287   101.11  *
*   2133   166.00 - 166.50   55.00 - 55.50    3.152   .049   136.98      5.170   .286   127.21  *
*   2134   166.00 - 166.50   55.50 - 56.00    3.152   .049   154.56      5.090   .248   138.31  *
*   2135   166.00 - 166.50   56.00 - 56.50    3.104   .000   175.49      4.974   .218   159.52  *
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                          SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2      LAT1 - LAT2       A(H)     C(H)    R(H)         A(N)    B(N)     R(N)

  2136   166.00 - 166.50    56.50 - 57.00     2.979    .000    177.57       4.765    .294    162.07
  2137   166.00 - 166.50    57.00 - 57.50     2.979    .000    191.23       4.571    .255    191.76
  2138   166.00 - 166.50    57.50 - 58.00     2.803    .000    194.57       4.153    .303    200.09
  2139   166.00 - 166.50    58.00 - 58.50     2.803    .000    214.41       3.830    .215    197.21
  2140   166.00 - 166.50    58.50 - 59.00     2.502    .000    205.05       3.709    .267    219.82
  2141   166.00 - 166.50    59.00 - 59.50     2.502    .000    229.69       3.600    .290    245.78
  2142   166.00 - 166.50    59.50 - 60.00     2.502    .000    256.61       3.081    .318    229.21
  2143   166.00 - 166.50    60.00 - 60.50      .000    .000       .00       2.296    .225    180.03
  2144   166.00 - 166.50    60.50 - 61.00      .000    .000       .00       2.296    .225    162.66
  2145   166.00 - 166.50    61.00 - 61.50     2.803    .000    224.41       2.296    .225    151.29
  2146   166.00 - 166.50    61.50 - 62.00     2.803    .000    191.58       3.332    .430    232.51
  2147   166.00 - 166.50    62.00 - 62.50     2.803    .000    158.58       3.498    .290    210.35
  2148   166.00 - 166.50    62.50 - 63.00     2.979    .000    140.21       3.542    .271    184.45
  2149   166.00 - 166.50    63.00 - 63.50     3.104    .000    111.92       3.542    .271    132.36
  2150   166.00 - 166.50    63.50 - 64.00     3.104    .000     63.33       3.653    .262    126.68
  2151   166.00 - 166.50    64.00 - 64.50     3.104    .000     18.47       3.753    .248     90.15
  2152   166.00 - 166.50    64.50 - 65.00     3.104    .000     59.32       3.758    .239     47.06
  2153   166.00 - 166.50    65.00 - 65.50     3.104    .000     71.06       3.779    .235     76.54
  2154   166.00 - 166.50    65.50 - 66.00     3.104    .000     51.69       3.779    .235     97.32
  2155   166.00 - 166.50    66.00 - 66.50     3.104    .000     18.35       3.758    .239    116.24
  2156   166.00 - 166.50    66.50 - 67.00     3.104    .000     61.32       3.758    .239    133.23
  2157   166.00 - 166.50    67.00 - 67.50     3.104    .000    108.33       3.758    .239    142.99
  2158   166.00 - 166.50    67.50 - 68.00     2.803    .000    119.05       3.758    .239    134.82
  2159   166.00 - 166.50    68.00 - 68.50     2.803    .000    154.18       3.579    .200     90.77
  2160   166.00 - 166.50    68.50 - 69.00     2.803    .000    189.02       3.472    .257    119.82
  2161   166.00 - 166.50    69.00 - 69.50     2.502    .000    207.24       3.421    .261    160.56
  2162   166.00 - 166.50    69.50 - 70.00      .000    .000       .00       3.421    .261    196.86
  2163   166.50 - 167.00    53.00 - 53.50     3.041    .061    102.87       5.181    .286     44.79
  2164   166.50 - 167.00    53.50 - 54.00     3.103    .001    111.17       5.181    .286     55.17
  2165   166.50 - 167.00    54.00 - 54.50     3.103    .001    119.91       5.130    .334     63.12
  2166   166.50 - 167.00    54.50 - 55.00     3.152    .049    133.79       5.178    .287    107.02
  2167   166.50 - 167.00    55.00 - 55.50     3.152    .049    147.41       5.170    .266    126.90
  2168   166.50 - 167.00    55.50 - 56.00     3.152    .049    159.86       5.088    .249    118.36
  2169   166.50 - 167.00    56.00 - 56.50     3.104    .000    174.39       4.970    .219    159.65
  2170   166.50 - 167.00    56.50 - 57.00     2.979    .000    170.44       4.759    .295    141.22
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*                          *      SEISMIC MAP OF ALASKA      *                                     *
***************************************************************************************************
*  SEIS ID   LONG1 - LONG2    LAT1 - LAT2      A(H)    C(H)    R(H)        A(N)    C(N)    R(N)    *
***************************************************************************************************
*                                                                                                  *
*   2171    166.50 - 167.00   57.00 - 57.50   2.979   .000   181.73       4.549   .261   183.93    *
*   2172    166.50 - 167.00   57.50 - 58.00   2.803   .000   182.25       4.092   .331   194.01    *
*   2173    166.50 - 167.00   58.00 - 58.50   2.803   .000   203.63       3.718   .228   136.84    *
*   2174    166.50 - 167.00   58.50 - 59.00   2.502   .000   191.51       3.650   .254   216.45    *
*   2175    166.50 - 167.00   59.00 - 59.50   2.502   .000   217.69       3.508   .294   237.36    *
*   2176    166.50 - 167.00   59.50 - 60.00   2.502   .000   245.93       3.081   .318   230.84    *
*   2177    166.50 - 167.00   60.00 - 60.50    .000   .000      .00       2.296   .225   193.59    *
*   2178    166.50 - 167.00   60.50 - 61.00    .000   .000      .00       2.296   .225   177.56    *
*   2179    166.50 - 167.00   61.00 - 61.50   2.803   .000   227.77       2.296   .225   167.20    *
*   2180    166.50 - 167.00   61.50 - 62.00   2.803   .000   195.01       2.984   .309   199.92    *
*   2181    166.50 - 167.00   62.00 - 62.50   2.803   .000   161.91       3.258   .173   137.87    *
*   2182    166.50 - 167.00   62.50 - 63.00   2.979   .000   142.94       3.329   .176   165.61    *
*   2183    166.50 - 167.00   63.00 - 63.50   3.104   .000   114.76       3.329   .176   135.30    *
*   2184    166.50 - 167.00   63.50 - 64.00   3.104   .000    68.21       3.614   .286   130.52    *
*   2185    166.50 - 167.00   64.00 - 64.50   3.104   .000    32.89       3.699   .273    98.93    *
*   2186    166.50 - 167.00   64.50 - 65.00   3.104   .000    62.52       3.705   .263    71.21    *
*   2187    166.50 - 167.00   65.00 - 65.50   3.104   .000    65.35       3.730   .255    84.97    *
*   2188    166.50 - 167.00   65.50 - 66.00   3.104   .000    44.58       3.730   .255    94.79    *
*   2189    166.50 - 167.00   66.00 - 66.50   3.104   .000    30.16       3.753   .248   116.73    *
*   2190    166.50 - 167.00   66.50 - 67.00   3.104   .000    64.11       3.753   .248   137.62    *
*   2191    166.50 - 167.00   67.00 - 67.50   3.104   .000   108.79       3.753   .248   149.43    *
*   2192    166.50 - 167.00   67.50 - 68.00   2.803   .000   118.79       3.758   .239   147.31    *
*   2193    166.50 - 167.00   68.00 - 68.50   2.803   .000   153.76       3.579   .200   117.73    *
*   2194    166.50 - 167.00   68.50 - 69.00   2.803   .000   188.55       3.472   .257   134.18    *
*   2195    166.50 - 167.00   69.00 - 69.50   2.502   .000   207.71       3.421   .261   167.44    *
*   2196    166.50 - 167.00   69.50 - 70.00    .000   .000      .00       3.421   .261   201.54    *
*   2197    167.00 - 167.50   52.00 - 52.50   3.041   .061   138.[illegible]       5.183   .282    65.69    *
*   2198    167.00 - 167.50   52.50 - 53.00   3.041   .061   127.18       5.184   .283    38.17    *
*   2199    167.00 - 167.50   53.00 - 53.50   3.041   .061   122.55       5.184   .283    43.35    *
*   2200    167.00 - 167.50   53.50 - 54.00   3.103   .001   129.48       5.184   .283    50.09    *
*   2201    167.00 - 167.50   54.00 - 54.50   3.103   .001   136.27       5.128   .329    74.20    *
*   2202    167.00 - 167.50   54.50 - 55.00   3.103   .001   146.10       5.117   .327   105.34    *
*   2203    167.00 - 167.50   55.00 - 55.50   3.103   .001   156.24       5.109   .324   100.19    *
*   2204    167.00 - 167.50   55.50 - 56.00   3.103   .001   163.07       5.020   .276   136.31    *
*   2205    167.00 - 167.50   56.00 - 56.50   2.979   .000   157.42       4.897   .231   144.55    *
*                                                                                                  *
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
2206	167.00 - 167.50	56.50 - 57.00	2.803	.000	140.43	4.733	.284	87.49
2207	167.00 - 167.50	57.00 - 57.50	2.803	.000	149.07	4.506	.253	174.93
2208	167.00 - 167.50	57.50 - 58.00	2.502	.000	133.20	3.945	.320	178.45
2209	167.00 - 167.50	58.00 - 58.50	2.803	.000	191.55	3.643	.267	180.92
2210	167.00 - 167.50	58.50 - 59.00	2.502	.000	178.96	3.600	.290	215.39
2211	167.00 - 167.50	59.00 - 59.50	2.502	.000	206.73	3.488	.312	240.27
2212	167.00 - 167.50	59.50 - 60.00	2.502	.000	236.29	3.081	.318	232.60
2213	167.00 - 167.50	60.00 - 60.50	.000	.000	.00	2.296	.225	207.55
2214	167.00 - 167.50	60.50 - 61.00	.000	.000	.00	2.296	.225	192.68
2215	167.00 - 167.50	61.00 - 61.50	2.803	.000	231.91	2.296	.225	183.18
2216	167.00 - 167.50	61.50 - 62.00	2.803	.000	199.35	2.984	.309	208.00
2217	167.00 - 167.50	62.00 - 62.50	2.803	.000	166.46	3.258	.173	193.79
2218	167.00 - 167.50	62.50 - 63.00	2.979	.000	147.44	3.329	.176	170.75
2219	167.00 - 167.50	63.00 - 63.50	3.104	.000	120.97	3.329	.176	141.09
2220	167.00 - 167.50	63.50 - 64.00	3.104	.000	80.17	3.460	.241	124.22
2221	167.00 - 167.50	64.00 - 64.50	3.104	.000	55.58	3.570	.271	102.85
2222	167.00 - 167.50	64.50 - 65.00	3.104	.000	70.37	3.579	.258	93.33
2223	167.00 - 167.50	65.00 - 65.50	3.104	.000	60.20	3.579	.258	91.27
2224	167.00 - 167.50	65.50 - 66.00	3.104	.000	30.39	3.579	.258	72.71
2225	167.00 - 167.50	66.00 - 66.50	3.104	.000	44.56	3.730	.255	111.25
2226	167.00 - 167.50	66.50 - 67.00	3.104	.000	71.66	3.730	.255	139.13
2227	167.00 - 167.50	67.00 - 67.50	3.104	.000	111.97	3.730	.255	153.53
2228	167.00 - 167.50	67.50 - 68.00	2.803	.000	120.14	3.753	.248	158.04
2229	167.00 - 167.50	68.00 - 68.50	2.803	.000	154.58	3.572	.212	137.07
2230	167.00 - 167.50	68.50 - 69.00	2.803	.000	189.11	3.460	.275	147.00
2231	167.00 - 167.50	69.00 - 69.50	2.502	.000	209.10	3.421	.261	174.73
2232	167.00 - 167.50	69.50 - 70.00	.000	.000	.00	3.421	.261	206.43
2233	167.50 - 168.00	52.00 - 52.50	3.041	.061	156.25	5.181	.280	56.00
2234	167.50 - 168.00	52.50 - 53.00	3.041	.061	146.11	5.182	.281	40.50
2235	167.50 - 168.00	53.00 - 53.50	3.041	.061	141.98	5.182	.281	32.77
2236	167.50 - 168.00	53.50 - 54.00	3.103	.001	147.03	5.181	.281	39.03
2237	167.50 - 168.00	54.00 - 54.50	3.103	.001	151.58	5.124	.327	31.49
2238	167.50 - 168.00	54.50 - 55.00	3.103	.001	157.71	5.112	.322	109.64
2239	167.50 - 168.00	55.00 - 55.50	3.103	.001	161.79	5.099	.318	125.29
2240	167.50 - 168.00	55.50 - 56.00	3.103	.001	160.20	5.007	.267	144.22

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                              SEISMIC MAP OF ALASKA

  GRID    LONG1 - LONG2     LAT1 - LAT2        A(H)    B(H)    R(H)        A(N)   B(N)    R(N)

  2241   167.50 - 168.00   56.00 - 56.50      2.979   .000   143.71       4.874   .217   110.82
  2242   167.50 - 168.00   56.50 - 57.00      2.803   .000   121.82       4.721   .278   139.89
  2243   167.50 - 168.00   57.00 - 57.50      2.803   .000   130.46       4.472   .248   182.02
  2244   167.50 - 168.00   57.50 - 58.00      2.502   .000   117.50       3.897   .339   176.81
  2245   167.50 - 168.00   58.00 - 58.50      2.502   .000   140.56       3.440   .244   158.36
  2246   167.50 - 168.00   58.50 - 59.00      2.502   .000   167.60       3.343   .272   187.79
  2247   167.50 - 168.00   59.00 - 59.50      2.502   .000   196.98       3.187   .329   213.94
  2248   167.50 - 168.00   59.50 - 60.00      2.502   .000   227.80       2.998   .367   232.50
  2249   167.50 - 168.00   60.00 - 60.50       .000   .000      .00        .000   .000      .00
  2250   167.50 - 168.00   60.50 - 61.00       .000   .000      .00        .000   .000      .00
  2251   167.50 - 168.00   61.00 - 61.50      2.803   .000   236.83       2.294   .225   199.22
  2252   167.50 - 168.00   61.50 - 62.00      2.803   .000   204.65       2.984   .309   215.96
  2253   167.50 - 168.00   62.00 - 62.50      2.803   .000   172.27       3.258   .173   200.25
  2254   167.50 - 168.00   62.50 - 63.00      2.979   .000   153.62       3.329   .176   176.75
  2255   167.50 - 168.00   63.00 - 63.50      3.104   .000   129.77       3.329   .176   148.01
  2256   167.50 - 168.00   63.50 - 64.00      3.104   .000    95.19       3.460   .241   133.92
  2257   167.50 - 168.00   64.00 - 64.50      3.104   .000    76.42       3.570   .271   117.26
  2258   167.50 - 168.00   64.50 - 65.00      3.104   .000    79.29       3.579   .258    99.24
  2259   167.50 - 168.00   65.00 - 65.50      3.104   .000    58.56       3.579   .258    83.41
  2260   167.50 - 168.00   65.50 - 66.00      3.104   .000    18.33       3.579   .258    48.60
  2261   167.50 - 168.00   66.00 - 66.50      3.104   .000    52.16       3.579   .258    91.73
  2262   167.50 - 168.00   66.50 - 67.00      3.104   .000    80.72       3.579   .258   125.81
  2263   167.50 - 168.00   67.00 - 67.50      3.104   .000   117.24       3.579   .258   141.55
  2264   167.50 - 168.00   67.50 - 68.00      2.803   .000   122.96       3.730   .255   164.43
  2265   167.50 - 168.00   68.00 - 68.50      2.803   .000   156.61       3.535   .210   147.11
  2266   167.50 - 168.00   68.50 - 69.00      2.803   .000   190.66       3.409   .281   153.02
  2267   167.50 - 168.00   69.00 - 69.50      2.502   .000   211.39       3.409   .281   181.59
  2268   167.50 - 168.00   69.50 - 70.00       .000   .000      .00       3.409   .281   211.86
  2269   168.00 - 168.50   52.00 - 52.50      3.041   .061   174.19       5.173   .275    50.93
  2270   168.00 - 168.50   52.50 - 53.00      3.041   .061   165.05       5.174   .276    31.51
  2271   168.00 - 168.50   53.00 - 53.50      3.041   .061   161.31       5.174   .275    43.96
  2272   168.00 - 168.50   53.50 - 54.00      3.103   .001   163.60       5.173   .276    57.05
  2273   168.00 - 168.50   54.00 - 54.50      3.103   .001   165.59       5.114   .321    97.44
  2274   168.00 - 168.50   54.50 - 55.00      3.103   .001   167.38       5.127   .329   115.38
  2275   168.00 - 168.50   55.00 - 55.50      3.103   .001   164.52       5.107   .322   128.51
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                          SEISMIC MAP OF ALASKA

  GRID   LONG1 - LONG2     LAT1 - LAT2      A(H)   C(H)    R(H)      A(N)   C(N)    R(N)

  2276  168.00 - 168.50   55.50 - 56.00    3.103   .001   153.31    5.005   .266   150.06
  2277  168.00 - 168.50   56.00 - 56.50    2.979   .000   125.63    4.863   .213   153.44
  2278  168.00 - 168.50   56.50 - 57.00    2.803   .000   100.48    4.701   .273   168.37
  2279  168.00 - 168.50   57.00 - 57.50    2.803   .000   110.37    4.420   .250   189.94
  2280  168.00 - 168.50   57.50 - 58.00    2.502   .000   102.89    3.764   .318   164.17
  2281  168.00 - 168.50   58.00 - 58.50    2.502   .000   128.60    3.348   .224   151.16
  2282  168.00 - 168.50   58.50 - 59.00    2.502   .000   157.70    3.215   .271   177.18
  2283  168.00 - 168.50   59.00 - 59.50    2.502   .000   188.63    2.936   .298   189.50
  2284  168.00 - 168.50   59.50 - 60.00    2.502   .000   220.62    2.822   .367   212.73
  2285  168.00 - 168.50   60.00 - 60.50     .000   .000      .00     .000   .000      .00
  2286  168.00 - 168.50   60.50 - 61.00     .000   .000      .00     .000   .000      .00
  2287  168.00 - 168.50   61.00 - 61.50    2.502   .000   215.74     .000   .000      .00
  2288  168.00 - 168.50   61.50 - 62.00    2.502   .000   182.89    2.896   .375   230.11
  2289  168.00 - 168.50   62.00 - 62.50    2.502   .000   150.79    3.227   .188   210.48
  2290  168.00 - 168.50   62.50 - 63.00    2.803   .000   145.83    3.302   .192   183.46
  2291  168.00 - 168.50   63.00 - 63.50    2.979   .000   129.53    3.302   .192   154.12
  2292  168.00 - 168.50   63.50 - 64.00    3.104   .000   110.63    3.460   .241   144.42
  2293  168.00 - 168.50   64.00 - 64.50    3.104   .000    94.10    3.570   .271   130.91
  2294  168.00 - 168.50   64.50 - 65.00    3.104   .000    88.31    3.579   .258   112.13
  2295  168.00 - 168.50   65.00 - 65.50    3.104   .000    63.32    3.579   .258    85.09
  2296  168.00 - 168.50   65.50 - 66.00    3.104   .000    31.27    3.579   .258    29.22
  2297  168.00 - 168.50   66.00 - 66.50    3.104   .000    59.97    3.579   .258    89.26
  2298  168.00 - 168.50   66.50 - 67.00    3.104   .000    90.16    3.579   .258   127.27
  2299  168.00 - 168.50   67.00 - 67.50    3.104   .000   124.08    3.579   .258   142.91
  2300  168.00 - 168.50   67.50 - 68.00    2.803   .000   127.08    3.579   .258   151.60
  2301  168.00 - 168.50   68.00 - 68.50    2.803   .000   159.76    3.474   .225   150.22
  2302  168.00 - 168.50   68.50 - 69.00    2.803   .000   193.18    3.310   .320   152.35
  2303  168.00 - 168.50   69.00 - 69.50    2.502   .000   214.57    3.346   .291   180.52
  2304  168.00 - 168.50   69.50 - 70.00     .000   .000      .00    3.346   .291   209.35
  2305  168.50 - 169.00   52.00 - 52.50    2.803   .000   198.99    5.184   .281    41.95
  2306  168.50 - 169.00   52.50 - 53.00    2.803   .000   185.62    5.185   .281    37.43
  2307  168.50 - 169.00   53.00 - 53.50    2.803   .000   178.01    5.185   .281    49.69
  2308  168.50 - 169.00   53.50 - 54.00    2.979   .000   186.63    5.180   .279    74.41
  2309  168.50 - 169.00   54.00 - 54.50    2.979   .000   180.90    5.120   .323    95.22
  2310  168.50 - 169.00   54.50 - 55.00    3.103   .001   175.16    5.128   .328   119.53
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*                          *      SEISMIC MAP OF ALASKA       *
*  GRID     LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)        A(N)    C(N)     R(N)   *
*
   2211    168.50 - 169.00    55.00 - 55.50      3.103    .001   164.81       5.094    .313   130.00   *
   2212    168.50 - 169.00    55.50 - 56.00      3.103    .001   143.32       4.987    .253   153.49   *
   2213    168.50 - 169.00    56.00 - 56.50      2.979    .000   104.60       4.835    .204   169.95   *
   2214    168.50 - 169.00    56.50 - 57.00      2.803    .000    77.22       4.650    .263   172.03   *
   2215    168.50 - 169.00    57.00 - 57.50      2.803    .000    89.81       4.316    .240   182.93   *
   2216    168.50 - 169.00    57.50 - 58.00      2.502    .000    89.90       3.646    .244   150.84   *
   2217    168.50 - 169.00    58.00 - 58.50      2.502    .000   118.46       3.348    .224   153.03   *
   2218    168.50 - 169.00    58.50 - 59.00      2.502    .000   149.55       3.215    .271   179.21   *
   2219    168.50 - 169.00    59.00 - 59.50      2.502    .000   181.87       2.939    .298   185.91   *
   2220    168.50 - 169.00    59.50 - 60.00      2.502    .000   214.87       2.822    .367   212.73   *
   2221    168.50 - 169.00    60.00 - 60.50       .000    .000      .00        .000    .000      .00   *
   2222    168.50 - 169.00    60.50 - 61.00       .000    .000      .00        .000    .000      .00   *
   2223    168.50 - 169.00    61.00 - 61.50      2.502    .000   220.38        .000    .000      .00   *
   2224    168.50 - 169.00    61.50 - 62.00      2.502    .000   188.34       2.896    .375   236.16   *
   2225    168.50 - 169.00    62.00 - 62.50      2.502    .000   157.35       3.227    .188   217.41   *
   2226    168.50 - 169.00    62.50 - 63.00      2.803    .000   153.56       3.302    .192   190.61   *
   2227    168.50 - 169.00    63.00 - 63.50      2.979    .000   140.14       3.302    .192   162.56   *
   2228    168.50 - 169.00    63.50 - 64.00      2.979    .000   114.28       3.436    .260   153.01   *
   2229    168.50 - 169.00    64.00 - 64.50      2.979    .000    98.64       3.550    .286   141.54   *
   2230    168.50 - 169.00    64.50 - 65.00      2.979    .000    87.84       3.560    .272   121.69   *
   2231    168.50 - 169.00    65.00 - 65.50      2.979    .000    65.45       3.579    .258    92.80   *
   2232    168.50 - 169.00    65.50 - 66.00      2.979    .000    45.98       3.579    .258    49.40   *
   2233    168.50 - 169.00    66.00 - 66.50      3.104    .000    71.54       3.579    .258    94.96   *
   2234    168.50 - 169.00    66.50 - 67.00      3.104    .000   100.27       3.579    .258   129.04   *
   2235    168.50 - 169.00    67.00 - 67.50      3.104    .000   132.16       3.579    .258   142.09   *
   2236    168.50 - 169.00    67.50 - 68.00      2.803    .000   132.35       3.579    .258   150.99   *
   2237    168.50 - 169.00    68.00 - 68.50      2.803    .000   163.95       3.471    .225   152.54   *
   2238    168.50 - 169.00    68.50 - 69.00      2.803    .000   196.62       3.310    .320   155.90   *
   2239    168.50 - 169.00    69.00 - 69.50      2.502    .000   218.58       3.222    .342   173.20   *
   2240    168.50 - 169.00    69.50 - 70.00       .000    .000      .00       3.222    .342   202.56   *
   2241    169.00 - 169.50    51.00 - 51.50      2.502    .000   231.64       5.187    .278    68.07   *
   2242    169.00 - 169.50    51.50 - 52.00      2.502    .000   212.90       5.188    .279    60.35   *
   2243    169.00 - 169.50    52.00 - 52.50      2.502    .000   198.43       5.188    .279    28.88   *
   2244    169.00 - 169.50    52.50 - 53.00      2.502    .000   189.22       5.189    .279    37.12   *
   2245    169.00 - 169.50    53.00 - 53.50      2.502    .000   186.05       5.189    .279    57.10   *
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*                                          *     SEISMIC MAP OF ALASKA      *                                  *
*   GRID     LONG1 - LONG2      LAT1 - LAT2         A(H)     B(H)      R(H)          A(N)    B(N)       R(N)     *
*
*   2246    169.00 - 169.50     53.50 - 54.00      2.803     .000    199.01          5.184   .277      70.91     *
*   2247    169.50 - 170.00     51.00 - 51.50       .000     .000       .00          5.188   .281      61.38     *
*   2248    169.50 - 170.00     51.50 - 52.00       .000     .000       .00          5.188   .281      57.17     *
*   2249    169.50 - 170.00     52.00 - 52.50       .000     .000       .00          5.189   .281      26.84     *
*   2250    169.50 - 170.00     52.50 - 53.00       .000     .000       .00          5.190   .282      36.77     *
*   2251    169.50 - 170.00     53.00 - 53.50       .000     .000       .00          5.190   .282      41.99     *
*   2252    169.50 - 170.00     53.50 - 54.00      2.502     .000    208.10          5.185   .279      50.24     *
*   2253    170.00 - 170.50     51.00 - 51.50       .000     .000       .00          5.198   .285      59.36     *
*   2254    170.00 - 170.50     51.50 - 52.00       .000     .000       .00          5.199   .285      53.22     *
*   2255    170.00 - 170.50     52.00 - 52.50       .000     .000       .00          5.199   .286      36.32     *
*   2256    170.00 - 170.50     52.50 - 53.00       .000     .000       .00          5.200   .286      45.20     *
*   2257    170.00 - 170.50     53.00 - 53.50       .000     .000       .00          5.199   .285      47.26     *
*   2258    170.00 - 170.50     53.50 - 54.00      2.502     .000    207.24          5.194   .283      73.59     *
*   2259    170.50 - 171.00     51.00 - 51.50       .000     .000       .00          5.212   .293      43.04     *
*   2260    170.50 - 171.00     51.50 - 52.00       .000     .000       .00          5.213   .293      47.88     *
*   2261    170.50 - 171.00     52.00 - 52.50       .000     .000       .00          5.213   .293      36.77     *
*   2262    170.50 - 171.00     52.50 - 53.00       .000     .000       .00          5.213   .293      42.45     *
*   2263    170.50 - 171.00     53.00 - 53.50       .000     .000       .00          5.213   .293      54.23     *
*   2264    170.50 - 171.00     53.50 - 54.00      2.502     .000    208.10          5.208   .291      79.18     *
*   2265    171.00 - 171.50     51.00 - 51.50      3.062     .671    194.61          5.216   .293      43.87     *
*   2266    171.00 - 171.50     51.50 - 52.00      3.062     .671    197.64          5.216   .293      36.86     *
*   2267    171.00 - 171.50     52.00 - 52.50      3.062     .671    206.48          5.217   .293      33.44     *
*   2268    171.00 - 171.50     52.50 - 53.00      3.062     .671    220.42          5.217   .293      46.67     *
*   2269    171.50 - 172.00     51.00 - 51.50      3.062     .671    173.04          5.226   .302      45.22     *
*   2270    171.50 - 172.00     51.50 - 52.00      3.062     .671    176.45          5.226   .302      59.96     *
*   2271    171.50 - 172.00     52.00 - 52.50      3.062     .671    186.29          5.227   .302      49.55     *
*   2272    171.50 - 172.00     52.50 - 53.00      3.062     .671    201.63          5.227   .302      62.40     *
*   2273    172.00 - 172.50     51.00 - 51.50      3.062     .671    151.49          5.254   .296      71.29     *
*   2274    172.00 - 172.50     51.50 - 52.00      3.062     .671    155.37          5.254   .296      69.76     *
*   2275    172.00 - 172.50     52.00 - 52.50      3.062     .671    166.46          5.254   .296      59.17     *
*   2276    172.00 - 172.50     52.50 - 53.00      3.062     .671    183.47          5.254   .296      68.99     *
*   2277    172.50 - 173.00     51.00 - 51.50      3.062     .671    129.95          5.347   .242      78.22     *
*   2278    172.50 - 173.00     51.50 - 52.00      3.062     .671    134.45          5.347   .242      58.02     *
*   2279    172.50 - 173.00     52.00 - 52.50      3.062     .671    147.13          5.348   .242      64.14     *
*   2280    172.50 - 173.00     52.50 - 53.00      3.062     .671    166.13          5.347   .242      69.84     *
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*                          *      SEISMIC MAP OF ALASKA       *                                 *
*************************************************************************************************
*   GRID    LONG1 - LONG2      LAT1 - LAT2         A(H)    B(H)    R(H)        A(N)   B(N)    R(N)    *
*************************************************************************************************
*                                                                                               *
*   2381   173.00 - 173.50    51.00 - 51.50       3.062    .671   108.43      5.346   .242   66.74    *
*   2382   173.00 - 173.50    51.50 - 52.00       3.062    .671   113.79      5.346   .242   41.80    *
*   2383   173.00 - 173.50    52.00 - 52.50       3.062    .671   128.53      5.346   .242   47.39    *
*   2384   173.00 - 173.50    52.50 - 53.00       3.062    .671   149.90      5.346   .242   58.72    *
*   2385   173.50 - 174.00    51.00 - 51.50       3.062    .671    86.95      5.370   .254   73.30    *
*   2386   173.50 - 174.00    51.50 - 52.00       3.062    .671    93.55      5.370   .254   37.83    *
*   2387   173.50 - 174.00    52.00 - 52.50       3.062    .671   111.00      5.370   .254   55.01    *
*   2388   173.50 - 174.00    52.50 - 53.00       3.062    .671   135.18      5.370   .254   49.96    *
*   2389   174.00 - 174.50    51.00 - 51.50       3.062    .671    65.55      5.373   .256   65.92    *
*   2390   174.00 - 174.50    51.50 - 52.00       3.062    .671    74.07      5.373   .256   40.02    *
*   2391   174.00 - 174.50    52.00 - 52.50       3.062    .671    95.17      5.373   .256   61.06    *
*   2392   174.00 - 174.50    52.50 - 53.00       3.062    .671   122.51      5.372   .256   74.24    *
*   2393   174.50 - 175.00    51.00 - 51.50       3.062    .671    44.33      5.429   .224   40.49    *
*   2394   174.50 - 175.00    51.50 - 52.00       3.062    .671    56.17      5.429   .224   45.55    *
*   2395   174.50 - 175.00    52.00 - 52.50       3.062    .671    82.01      5.429   .224   55.22    *
*   2396   174.50 - 175.00    52.50 - 53.00       3.062    .671   112.59      5.428   .224   62.96    *
*   2397   175.00 - 175.50    51.00 - 51.50       3.062    .671    23.80      5.480   .216   50.81    *
*   2398   175.00 - 175.50    51.50 - 52.00       3.062    .671    41.91      5.480   .216   38.39    *
*   2399   175.00 - 175.50    52.00 - 52.50       3.062    .671    72.99      5.480   .216   58.28    *
*   2400   175.00 - 175.50    52.50 - 53.00       3.062    .671   106.20      5.479   .216   66.65    *
*   2401   175.50 - 176.00    51.00 - 51.50       3.062    .671    10.00      5.476   .209   59.58    *
*   2402   175.50 - 176.00    51.50 - 52.00       3.062    .671    35.92      5.476   .209   45.20    *
*   2403   175.50 - 176.00    52.00 - 52.50       3.062    .671    69.72      5.476   .209   64.40    *
*   2404   175.50 - 176.00    52.50 - 53.00       3.062    .671   103.98      5.476   .209   79.53    *
*   2405   176.00 - 176.50    51.00 - 51.50       3.062    .671    23.80      5.425   .238   42.00    *
*   2406   176.00 - 176.50    51.50 - 52.00       3.062    .671    41.91      5.425   .238   38.03    *
*   2407   176.00 - 176.50    52.00 - 52.50       3.062    .671    72.99      5.425   .238   52.03    *
*   2408   176.00 - 176.50    52.50 - 53.00       3.062    .671   106.20      5.425   .238   70.68    *
*   2409   176.50 - 177.00    51.00 - 51.50       3.062    .671    44.33      5.452   .247   36.61    *
*   2410   176.50 - 177.00    51.50 - 52.00       3.062    .671    56.17      5.452   .247   41.98    *
*   2411   176.50 - 177.00    52.00 - 52.50       3.062    .671    82.01      5.452   .247   71.26    *
*   2412   176.50 - 177.00    52.50 - 53.00       3.062    .671   112.59      5.451   .247   45.86    *
*   2413   177.00 - 177.50    51.00 - 51.50       3.062    .671    65.55      5.488   .256   36.29    *
*   2414   177.00 - 177.50    51.50 - 52.00       3.062    .671    74.07      5.488   .256   41.04    *
*   2415   177.00 - 177.50    52.00 - 52.50       3.062    .671    95.17      5.488   .256   70.19    *
*                                                                                               *
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	C(H)	R(H)	A(N)	C(N)	R(N)
2416	177.00 - 177.50	52.50 - 53.00	3.062	.671	122.51	5.488	.256	99.54
2417	177.50 - 178.00	51.00 - 51.50	3.062	.671	86.95	5.513	.265	40.06
2418	177.50 - 178.00	51.50 - 52.00	3.062	.671	93.55	5.513	.265	51.85
2419	177.50 - 178.00	52.00 - 52.50	3.062	.671	111.00	5.513	.265	78.79
2420	177.50 - 178.00	52.50 - 53.00	3.062	.671	135.18	5.513	.265	85.89
2421	178.00 - 178.50	51.00 - 51.50	3.062	.671	108.43	5.518	.265	34.79
2422	178.00 - 178.50	51.50 - 52.00	3.062	.671	113.79	5.518	.265	44.74
2423	178.00 - 178.50	52.00 - 52.50	3.062	.671	128.53	5.518	.265	67.39
2424	178.00 - 178.50	52.50 - 53.00	3.062	.671	149.90	5.518	.265	97.94
2425	178.50 - 179.00	51.00 - 51.50	3.062	.671	129.95	5.532	.271	34.34
2426	178.50 - 179.00	51.50 - 52.00	3.062	.671	134.45	5.532	.271	44.75
2427	178.50 - 179.00	52.00 - 52.50	3.062	.671	147.13	5.532	.272	67.30
2428	178.50 - 179.00	52.50 - 53.00	3.062	.671	166.13	5.532	.271	100.58
2429	179.00 - 179.50	51.00 - 51.50	3.062	.671	151.49	5.552	.280	24.79
2430	179.00 - 179.50	51.50 - 52.00	3.062	.671	155.37	5.552	.280	48.83
2431	179.00 - 179.50	52.00 - 52.50	3.062	.671	166.46	5.552	.280	76.36
2432	179.00 - 179.50	52.50 - 53.00	3.062	.671	183.47	5.552	.280	105.67
2433	179.50 - 180.00	51.00 - 51.50	3.062	.671	173.04	5.569	.289	30.91
2434	179.50 - 180.00	51.50 - 52.00	3.062	.671	176.45	5.569	.289	45.88
2435	179.50 - 180.00	52.00 - 52.50	3.062	.671	186.29	5.569	.289	61.57
2436	179.50 - 180.00	52.50 - 53.00	3.062	.671	201.63	5.569	.289	102.10
2437	180.00 - 180.50	51.00 - 51.50	3.062	.671	194.61	5.573	.295	41.49
2438	180.00 - 180.50	51.50 - 52.00	3.062	.671	197.64	5.573	.295	46.17
2439	180.00 - 180.50	52.00 - 52.50	3.062	.671	206.48	5.573	.295	70.04
2440	180.00 - 180.50	52.50 - 53.00	3.062	.671	220.42	5.573	.295	106.00
2441	180.50 - 181.00	51.00 - 51.50	.000	.000	.00	5.606	.307	29.00
2442	180.50 - 181.00	51.50 - 52.00	.000	.000	.00	5.606	.307	54.12
2443	180.50 - 181.00	52.00 - 52.50	.000	.000	.00	5.605	.307	82.12
2444	180.50 - 181.00	52.50 - 53.00	.000	.000	.00	5.605	.307	106.00
2445	181.00 - 181.50	51.00 - 51.50	.000	.000	.00	5.622	.314	31.06
2446	181.00 - 181.50	51.50 - 52.00	.000	.000	.00	5.622	.314	49.48
2447	181.00 - 181.50	52.00 - 52.50	.000	.000	.00	5.622	.314	77.81
2448	181.00 - 181.50	52.50 - 53.00	.000	.000	.00	5.622	.314	101.91
2449	181.50 - 182.00	51.00 - 51.50	2.802	.300	231.64	5.632	.320	34.53
2450	181.50 - 182.00	51.50 - 52.00	2.802	.300	212.90	5.632	.320	51.23

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                                   SEISMIC MAP OF ALASKA

   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    C(H)     R(H)         A(N)    C(N)     R(N)

   2451   181.50 - 182.00    52.00 - 52.50      2.802   .300    198.43       5.632   .320     64.24
   2452   181.50 - 182.00    52.50 - 53.00      2.802   .300    189.22       5.632   .320    106.34
   2453   182.00 - 182.50    51.00 - 51.50      2.802   .300    215.44       5.650   .331     39.11
   2454   182.00 - 182.50    51.50 - 52.00      2.802   .300    195.15       5.650   .331     49.41
   2455   182.00 - 182.50    52.00 - 52.50      2.802   .300    179.25       5.650   .331     75.48
   2456   182.00 - 182.50    52.50 - 53.00      2.802   .300    169.00       5.650   .331    106.12
   2457   182.50 - 183.00    51.00 - 51.50      3.103   .300    213.98       5.659   .336     39.67
   2458   182.50 - 183.00    51.50 - 52.00      3.103   .300    192.95       5.659   .336     52.72
   2459   182.50 - 183.00    52.00 - 52.50      3.103   .300    176.20       5.659   .336     71.54
   2460   182.50 - 183.00    52.50 - 53.00      3.103   .300    165.19       5.659   .336    102.63
   2461   183.00 - 183.50    51.00 - 51.50      3.103   .300    198.78       5.661   .336     40.21
   2462   183.00 - 183.50    51.50 - 52.00      3.103   .300    175.90       5.661   .336     37.56
   2463   183.00 - 183.50    52.00 - 52.50      3.103   .300    157.24       5.661   .336     66.31
   2464   183.00 - 183.50    52.50 - 53.00      3.103   .300    144.67       5.661   .336     93.45
   2465   183.50 - 184.00    51.00 - 51.50      3.103   .300    184.70       5.670   .337     41.43
   2466   183.50 - 184.00    51.50 - 52.00      3.103   .300    159.80       5.670   .337     33.30
   2467   183.50 - 184.00    52.00 - 52.50      3.103   .300    138.87       5.670   .337     61.02
   2468   183.50 - 184.00    52.50 - 53.00      3.103   .300    124.24       5.670   .337     91.19
   2469   184.00 - 184.50    51.00 - 51.50      3.103   .300    172.00       5.648   .337     43.31
   2470   184.00 - 184.50    51.50 - 52.00      3.103   .300    144.95       5.648   .337     33.69
   2471   184.00 - 184.50    52.00 - 52.50      3.103   .300    121.39       5.648   .337     47.77
   2472   184.00 - 184.50    52.50 - 53.00      3.103   .300    104.02       5.648   .337     77.89
   2473   184.50 - 185.00    51.00 - 51.50      3.103   .300    160.99       5.623   .340     45.19
   2474   184.50 - 185.00    51.50 - 52.00      3.103   .300    131.81       5.623   .340     33.76
   2475   184.50 - 185.00    52.00 - 52.50      3.103   .300    105.31       5.623   .340     41.40
   2476   184.50 - 185.00    52.50 - 53.00      3.103   .300     84.27       5.623   .340     70.15
   2477   185.00 - 185.50    51.00 - 51.50      3.103   .300    152.01       5.615   .343     42.94
   2478   185.00 - 185.50    51.50 - 52.00      3.103   .300    120.88       5.615   .343     29.88
   2479   185.00 - 185.50    52.00 - 52.50      3.103   .300     91.46       5.615   .343     36.30
   2480   185.00 - 185.50    52.50 - 53.00      3.103   .300     65.70       5.615   .343     70.70
   2481   185.50 - 186.00    51.00 - 51.50      3.103   .300    145.36       5.668   .311     41.01
   2482   185.50 - 186.00    51.50 - 52.00      3.103   .300    112.71       5.669   .311     33.21
   2483   185.50 - 186.00    52.00 - 52.50      3.103   .300     80.94       5.669   .311     39.04
   2484   185.50 - 186.00    52.50 - 53.00      3.103   .300     50.32       5.669   .311     71.95
   2485   186.00 - 186.50    51.00 - 51.50      3.103   .300    141.27       5.639   .321     40.12
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SEISMIC MAP OF ALASKA

GRID	LONG1 - LONG2	LAT1 - LAT2	A(H)	B(H)	R(H)	A(N)	B(N)	R(N)
2486	186.00 - 186.50	51.50 - 52.00	3.103	.300	107.69	5.639	.322	36.32
2487	186.00 - 186.50	52.00 - 52.50	3.103	.300	74.69	5.639	.322	39.02
2488	186.00 - 186.50	52.50 - 53.00	3.103	.300	42.26	5.639	.322	60.36
2489	186.50 - 187.00	51.00 - 51.50	3.103	.300	139.89	5.600	.334	47.32
2490	186.50 - 187.00	51.50 - 52.00	3.103	.300	106.01	5.601	.334	38.10
2491	186.50 - 187.00	52.00 - 52.50	3.103	.300	72.71	5.601	.334	28.73
2492	186.50 - 187.00	52.50 - 53.00	3.103	.300	41.43	5.601	.334	43.50
2493	187.00 - 187.50	51.00 - 51.50	3.103	.300	141.27	5.575	.329	54.90
2494	187.00 - 187.50	51.50 - 52.00	3.103	.300	107.69	5.575	.329	42.83
2495	187.00 - 187.50	52.00 - 52.50	3.103	.300	74.69	5.575	.329	33.79
2496	187.00 - 187.50	52.50 - 53.00	3.103	.300	42.26	5.575	.329	46.49
2497	187.50 - 188.00	51.00 - 51.50	3.103	.300	145.36	5.554	.328	[illegible]2.44
2498	187.50 - 188.00	51.50 - 52.00	3.103	.300	112.71	5.555	.328	[illegible]9.83
2499	187.50 - 188.00	52.00 - 52.50	3.103	.300	80.94	5.555	.328	37.73
2500	187.50 - 188.00	52.50 - 53.00	3.103	.300	50.32	5.555	.328	39.28
2501	188.00 - 188.50	51.00 - 51.50	3.103	.300	152.01	5.527	.325	70.02
2502	188.00 - 188.50	51.50 - 52.00	3.103	.300	120.88	5.527	.325	55.34
2503	188.00 - 188.50	52.00 - 52.50	3.103	.300	91.46	5.527	.325	42.14
2504	188.00 - 188.50	52.50 - 53.00	3.103	.300	65.70	5.527	.325	35.45
2505	188.50 - 189.00	51.00 - 51.50	3.103	.300	160.99	5.491	.320	86.89
2506	188.50 - 189.00	51.50 - 52.00	3.103	.300	131.81	5.492	.320	65.33
2507	188.50 - 189.00	52.00 - 52.50	3.103	.300	105.31	5.494	.320	45.63
2508	188.50 - 189.00	52.50 - 53.00	3.103	.300	84.27	5.494	.320	45.06
2509	189.00 - 189.50	51.00 - 51.50	3.103	.300	172.00	5.452	.311	105.46
2510	189.00 - 189.50	51.50 - 52.00	3.103	.300	144.95	5.466	.300	78.35
2511	189.00 - 189.50	52.00 - 52.50	3.103	.300	121.39	5.469	.301	61.51
2512	189.00 - 189.50	52.50 - 53.00	3.103	.300	104.02	5.469	.300	60.00
2513	189.50 - 190.00	51.00 - 51.50	3.103	.300	184.70	5.414	.305	106.84
2514	189.50 - 190.00	51.50 - 52.00	3.103	.300	159.80	5.430	.297	96.91
2515	189.50 - 190.00	52.00 - 52.50	3.103	.300	138.87	5.440	.300	77.81
2516	189.50 - 190.00	52.50 - 53.00	3.103	.300	124.24	5.442	.299	78.46

SEISMICITY FOR HAWAII

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******************************************************************************************
*                         *    SEISMIC MAP OF HAWAII    *                                *
******************************************************************************************
*  GRID    LONG1 - LONG2     LAT1 - LAT2      A(H)    O(H)    R(H)       A(N)   O(N)    R(N)     *
******************************************************************************************
*
*     1    154.00 - 154.50   18.00 - 18.50    4.169   .356   126.00      3.845   .204    37.11   *
*     2    154.00 - 154.50   18.50 - 19.00    4.182   .345   105.81      3.859   .200    73.89   *
*     3    154.00 - 154.50   19.00 - 19.50    4.253   .307   100.57      3.862   .197    71.79   *
*     4    154.00 - 154.50   19.50 - 20.00    4.253   .307   100.77      3.862   .197    76.55   *
*     5    154.00 - 154.50   20.00 - 20.50    4.253   .307   110.17      3.862   .197    90.54   *
*     6    154.00 - 154.50   20.50 - 21.00    4.253   .307   124.06      3.847   .188   108.50   *
*     7    154.50 - 155.00   18.00 - 18.50    4.171   .354   103.05      3.921   .197    77.83   *
*     8    154.50 - 155.00   18.50 - 19.00    4.185   .343    76.56      3.934   .191    59.08   *
*     9    154.50 - 155.00   19.00 - 19.50    4.256   .304    63.72      3.950   .193    44.57   *
*    10    154.50 - 155.00   19.50 - 20.00    4.256   .304    66.02      3.956   .190    53.00   *
*    11    154.50 - 155.00   20.00 - 20.50    4.256   .304    79.82      3.956   .190    73.26   *
*    12    154.50 - 155.00   20.50 - 21.00    4.256   .304    91.65      3.943   .184    91.04   *
*    13    155.00 - 155.50   18.00 - 18.50    4.174   .352    87.62      3.921   .197    75.04   *
*    14    155.00 - 155.50   18.50 - 19.00    4.187   .341    54.84      3.934   .191    44.12   *
*    15    155.00 - 155.50   19.00 - 19.50    4.260   .300    25.09      3.950   .193    14.48   *
*    16    155.00 - 155.50   19.50 - 20.00    4.260   .300    28.89      3.956   .190    23.71   *
*    17    155.00 - 155.30   20.00 - 20.50    4.260   .300    48.00      3.956   .190    57.11   *
*    18    155.00 - 155.50   20.50 - 21.00    4.260   .300    44.06      3.943   .184    47.06   *
*    19    155.50 - 156.00   18.00 - 18.50    4.174   .352    82.68      3.921   .197    74.70   *
*    20    155.50 - 156.00   18.50 - 19.00    4.187   .341    47.00      3.934   .191    37.35   *
*    21    155.50 - 156.00   19.00 - 19.50    4.260   .300    15.77      3.950   .193    18.68   *
*    22    155.50 - 156.00   19.50 - 20.00    4.260   .300    25.82      3.956   .190    24.73   *
*    23    155.50 - 156.00   20.00 - 20.50    4.260   .300    35.42      3.956   .190    46.15   *
*    24    155.50 - 156.00   20.50 - 21.00    4.260   .300    52.01      3.943   .184    46.41   *
*    25    156.00 - 156.50   18.00 - 18.50    4.174   .352    89.94      3.921   .197    84.90   *
*    26    156.00 - 156.50   18.50 - 19.00    4.187   .341    60.00      3.934   .191    59.50   *
*    27    156.00 - 156.50   19.00 - 19.50    4.260   .300    42.43      3.950   .193    45.52   *
*    28    156.00 - 156.50   19.50 - 20.00    4.260   .300    19.30      3.956   .190    38.40   *
*    29    156.00 - 156.50   20.00 - 20.50    4.260   .300    55.21      3.956   .190    67.38   *
*    30    156.00 - 156.50   20.50 - 21.00    4.260   .300    71.77      3.943   .184    79.78   *
*    31    156.00 - 156.50   21.00 - 21.50    4.260   .300    31.53      3.937   .187    56.35   *
*    32    156.00 - 156.50   21.50 - 22.00    3.969   .153    73.80      3.433   .136    66.71   *
*    33    156.50 - 157.00   18.00 - 18.50    4.174   .352   106.12      3.907   .192    98.14   *
*    34    156.50 - 157.00   18.50 - 19.00    4.187   .341    81.96      3.920   .185    67.64   *
*    35    156.50 - 157.00   19.00 - 19.50    4.260   .300    66.66      3.937   .187    24.95   *
*                                                                                        *
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************************************************************************************************
*                                 *     SEISMIC MAP OF HAWAII     *                            *
************************************************************************************************
*   GRID    LONG1 - LONG2      LAT1 - LAT2        A(H)    D(H)     R(H)        A(N)    D(N)     R(N)    *
************************************************************************************************
*                                                                                              *
*    36    156.50 - 157.00    19.50 - 20.00      4.260   .300     45.05       3.943   .184     63.33   *
*    37    156.50 - 157.00    20.00 - 20.5       4.260   .300     69.70       3.943   .184     84.68   *
*    38    156.50 - 157.00    20.50 - 21.00      4.260   .300     86.08       3.943   .184     89.73   *
*    39    156.50 - 157.00    21.00 - 21.50      4.260   .300     93.17       3.937   .187     40.52   *
*    40    156.50 - 157.00    21.50 - 22.00      3.969   .153     89.44       3.433   .136     30.23   *
*    41    157.00 - 157.50    19.00 - 19.50      4.260   .300     96.54       3.937   .187     72.30   *
*    42    157.00 - 157.50    19.50 - 20.00      4.260   .300     86.09       3.943   .184     87.76   *
*    43    157.00 - 157.50    20.00 - 20.50      4.260   .300     57.89       3.943   .184    105.56   *
*    44    157.00 - 157.50    20.50 - 21.00      4.260   .300    100.78       3.943   .184    111.39   *
*    45    157.00 - 157.50    21.00 - 21.50      4.260   .300     61.35       3.937   .187    102.07   *
*    46    157.00 - 157.50    21.50 - 22.00      3.969   .153    105.73       3.433   .136     75.55   *
*    47    157.50 - 158.00    19.00 - 19.50      4.187   .376    125.92       3.658   .207     98.60   *
*    48    157.50 - 158.00    19.50 - 20.00      4.187   .376    117.25       3.671   .198    104.48   *
*    49    157.50 - 158.00    20.00 - 20.50      4.187   .376    113.39       3.671   .198    115.50   *
*    50    157.50 - 158.00    20.50 - 21.00      4.187   .376    125.06       3.671   .198    122.50   *
*    51    157.50 - 158.00    21.00 - 21.50      4.260   .300    133.14       3.937   .187    145.74   *
*    52    157.50 - 158.00    21.50 - 22.00      3.969   .153    132.72       3.433   .136    116.51   *
*    53    158.00 - 158.50    19.00 - 19.50      3.794   .331    141.06       3.196   .241    107.62   *
*    54    158.00 - 158.50    19.50 - 20.00      3.794   .331    130.14       3.241   .200    112.81   *
*    55    158.00 - 158.50    20.00 - 20.50      3.794   .331    126.53       3.241   .200    119.19   *
*    56    158.00 - 158.50    20.50 - 21.00      3.794   .331    130.29       3.241   .200    124.10   *
*    57    158.00 - 158.50    21.00 - 21.50      4.187   .376    172.30       3.658   .207    157.85   *
*    58    158.00 - 158.50    21.50 - 22.00      3.874   .243    158.77       3.273   .155    139.84   *
*    59    158.00 - 158.50    22.00 - 22.50      3.236   .437    127.77       2.913   .192    121.51   *
*    60    158.00 - 158.50    22.50 - 23.00      3.209   .451    152.40       2.881   .147    139.47   *
*    61    158.50 - 159.00    19.00 - 19.50      2.875   .000    136.52       3.135   .321    139.27   *
*    62    158.50 - 159.00    19.50 - 20.00      2.875   .000    121.60       3.190   .274    144.06   *
*    63    158.50 - 159.00    20.00 - 20.50      2.875   .000    113.80       3.190   .274    148.52   *
*    64    158.50 - 159.00    20.50 - 21.00      2.875   .000    112.98       3.190   .274    154.00   *
*    65    158.50 - 159.00    21.00 - 21.5       3.794   .331    172.13       3.241   .200    157.17   *
*    66    158.50 - 159.00    21.50 - 22.00      3.794   .331    186.77       2.854   .085    134.50   *
*    67    158.50 - 159.00    22.00 - 22.50      3.209   .451    153.57       2.780   .175    140.97   *
*    68    158.50 - 159.00    22.50 - 23.00      3.172   .477    175.81       2.780   .175    156.86   *
*    69    159.00 - 159.50    21.00 - 21.50      2.875   .000    149.59       3.190   .274    189.82   *
*    70    159.00 - 159.50    21.50 - 22.00      2.875   .000    161.31       2.722   .255    162.80   *
*                                                                                              *
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                                   SEISMIC MAP OF HAWAII

  GRID      LONG1 - LONG2      LAT1 - LAT2        A(H)    O(H)      R(H)        A(N)    O(N)     R(N)

   71     159.00 - 159.5     22.00 - 22.50      2.699    .000    163.44       2.722    .255   170.50
   72     159.00 - 159.5     22.50 - 23.00      2.398    .000    165.39       2.722    .255   184.26
   73     159.50 - 160.0     21.00 - 21.50      2.699    .000    168.10        .000    .000      .00
   74     159.50 - 160.0     21.50 - 22.00      2.699    .000    176.82        .000    .000      .00
   75     159.50 - 160.0     22.00 - 22.50      2.699    .000    191.13        .000    .000      .00
   76     159.50 - 160.0     22.50 - 23.00      2.398    .000    191.47        .000    .000      .00
   77     160.00 - 160.5     21.00 - 21.50       .000    .000       .00        .000    .000      .00
   78     160.00 - 160.5     21.50 - 22.00       .000    .000       .00        .000    .000      .00
   79     160.00 - 160.5     22.00 - 22.50       .000    .000       .00        .000    .000      .00
   80     160.00 - 160.5     22.50 - 23.00       .000    .000       .00        .000    .000      .00
   81     160.50 - 161.0     21.00 - 21.50       .000    .000       .00        .000    .000      .00
   82     160.50 - 161.0     21.50 - 22.00       .000    .000       .00        .000    .000      .00
   83     160.50 - 161.0     22.00 - 22.50       .000    .000       .00        .000    .000      .00
   84     160.50 - 161.0     22.50 - 23.00       .000    .000       .00        .000    .000      .00
   85     161.00 - 161.5     21.00 - 21.50       .000    .000       .00        .000    .000      .00
   86     161.00 - 161.5     21.50 - 22.00       .000    .000       .00        .000    .000      .00
   87     161.00 - 161.5     22.00 - 22.50       .000    .000       .00        .000    .000      .00
   88     161.00 - 161.5     22.50 - 23.00       .000    .000       .00        .000    .000      .00
   89     161.50 - 162.0     21.00 - 21.50       .000    .000       .00        .000    .000      .00
   90     161.50 - 162.0     21.50 - 22.00       .000    .000       .00        .000    .000      .00
   91     161.50 - 162.0     22.00 - 22.50       .000    .000       .00        .000    .000      .00
   92     161.50 - 162.0     22.50 - 23.00       .000    .000       .00        .000    .000      .00
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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

A methodology is presented for survey and evaluation of existing buildings to determine the risk to life safety under natural hazard conditions and estimate the amount of expected damage. Damage to both structural and nonstructural building components resulting from the extreme natural environments encountered in earthquakes, hurricanes, and tornadoes is considered. The methodology has the capability of treating a large class of structural types including braced and unbraced steel frames, concrete frames with and without shear walls, bearing wall structures, and long-span roof structures. Three independent but related sets of procedures for estimating damage for each of the natural hazards are included in the methodology. The first set of procedures provides a means for qualitatively determining the damage level on the basis of data collected in field surveys of the building. The second set utilizes a structural analysis of the building to determine the damage level as a function of the behavior of critical elements. The third set is based on a computer analysis of the entire structure. All three sets of procedures are based on the current state of the art. The procedures are presented in a format which allows updating and refining. Numerical examples illustrating application of the procedures are included.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Buildings; Damage; Disaster; Dynamic Analysis; Earthquakes; Hurricanes; Natural hazards; Structural engineering; Tornadoes; Wind.

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